SCIENCE EDUCATION

Formerly GENERAL SCIENCE QUARTERLY

SERVING TEACHERS IN ELEMENTARY SCHOOLS,
JUNIOR AND SENIOR HIGH SCHOOLS, COLLEGES,
AND PROFESSIONAL SCHOOLS FOR TEACHERS

VOLUME 30 APRIL, 1946 NUMBER 3

CONTENTS

(The Contents of SCIENCE EDUCATION are indexed in the Education Index)

INTRODUCING THE CONTRIBUTORS

The Social Significance of Scientific Research is a stimulating article on a vital aspect of science in the work of the world. Dr. T. Swann Harding is Editor of USDA in the Office of Information of the Department of Agriculture. He is the author of numerous technical papers as well as the two popular books, *The Popular Practice of Fraud* and *The Degradation of Science*.

Although the employment of scientific methods in their research, teaching, and thinking might be assumed for those engaged in scientific research or teaching, yet such an assumption is often contrary to the facts. Yes, too many, if not most, science teachers, use unscientific methods in their science teaching. Dr. Paul F. Brandwein ("Unscientific Method in Science Teaching") is Chairman of the Science Department of the Forest Hills High School, Forest Hills, New York. He is also instructor in the Teaching of Natural Sciences in the 1946 Summer Session of Teachers College, Columbia University.

The Science Education of the Non-College High School Student discusses a most important question in secondary science teaching. The author, John Gammons Read, is head of the physical sciences at Rhode Island College of Education, Providence, Rhode Island. He has contributed numerous articles on visual education and conservation.

The other contributors have had articles in Science Education during the year and were introduced at that time: Dr. Smith, February and March; Mr. Carleton, February; Lt. Keeslar, December and February; Dr. Oakes, April and October; Dr. Pruitt, February and March.

SCIENCE EDUCATION

VOLUME 30 APRIL, 1946 NUMBER 3

THE SOCIAL SIGNIFICANCE OF SCIENTIFIC RESEARCH *

T. SWANN HARDING

Office of Information, Department of Agriculture, Washington, D. C.

THE utilization of knowledge acquired by fundamental research may be constructive or destructive. It may serve to build a civilization at peace or to destroy one at war.

The impact of scientific discovery may be disruptive even of a society at peace. Wrongly applied scientific knowledge has often resulted in social confusion and economic disorder. But in the last analysis the form assumed by our social and economic system as a whole, and by agriculture in particular, depends primarily upon our discoveries in natural science. The effect of such discoveries upon our society is, in turn, largely determined by the policies we adopt for their utilization.

WHAT IS SCIENTIFIC METHOD?

We commonly call this a scientific age and proudly point to our achievements through scientific method. What is scientific method as distinguished from the methods of magic or pre-science, or from what may be called ordinary, unscientific methods? To help our understanding, we might consider a theory of the nature of the universe held by certain philosophers in the sixth century.

According to this theory, the earth was a flat parallelogram. In its center was the ocean, and the sky was glued to high walls on the edges. The preponents of this theory held it heretical to believe in the existence of the antipodes, to be misled by Greek fables, or to be deceived by human science. For man should appeal to authority, to the law, and to the testimony. Sacred writ said that man lived upon the face of the earth; hence he could not live upon more faces thereof than one, or upon the earth's back. Sacred writings compared the earth to a tabernacle; hence it must obviously have the shape of the tabernacle of Moses.

Insofar as this reasoning seems strange to us as proof of the earth's shape, we have been influenced by scientific method. The mere appeal to constituted authority does not, in itself, move us as it once might have.

But the full experimental testing of hypotheses, an integral part of the scientific method, was from time to time carried on, however imperfectly, rather early in history. Leonardo da Vinci (1452–1519), for instance, used the modern method of science to an amazing extent. Actually he discovered many general principles usually attributed to Galileo (1564–1642) and to others who came much later. But he described them in fragmentary notes full of ill-defined terms and never bothered to publish a logical, systematic treatise. Part

* This manuscript was condensed by the Editor from an article entitled *Science and Agricultural Policy* in the 1940 U.S.D.A. Yearbook, *Farmers in a Changing World*, pages 1081–1110. It is printed here by permission of Dr. Harding.

of the scientific method consists in the complete and orderly statement of results.

Leonardo's method was scientific because he first observed phenomena, next tried to reproduce them artificially under controlled conditions, then sought relationships between their various factors, applied measurements to these relationships, and finally deduced general principles or laws.

It certainly seems that Leonardo understood the experimental method as thoroughly as did Galileo a century later. But because he did not relate his findings in a system of logic or a pattern of truth, he did not produce a science. Even a failure properly to disseminate scientific knowledge impedes the progress of perfecting the method of science.

What, then, constitutes this method? The scientist first observes natural phenomena. Certain events in nature excite his curiosity. He faces a problem. His mind yearns for an explanation. So he formulates a hypothesis. He then tests this by experiment, performing certain operations under carefully controlled conditions. If the experiment casts doubt on his hypothesis, he changes the hypothesis. Ultimately, after enough experiments have been performed, the scientist tentatively assumes that his hypothesis is sound and deduces from it certain general principles or laws. Finally he puts these principles together logically and systematically in a pattern.

Random observations and experiments, however accurate or informative, do not of themselves constitute a science. Atomic theories and theories of evolution abounded long before they could be established scientifically. The germ theory of disease was limned long before Pasteur. He, however, confirmed it as a fact by carefully controlled observation and experimentation. On the basis of this work he erected a new hypothesis which immediately ordered thousands of hitherto isolated facts and findings into a system that gave them all meaning.

THE PATTERN OF SCIENTIFIC TRUTH

We should now consider the nature of scientific truth, and try to understand why a scientist may at times even maintain the right to hold, side by side, two theories that appear to be mutually exclusive—for instance those about the radiation of light—on the grounds that each is verifiable experimentally in a particular region. The scientist is doubly skeptical. He doubts both sense perception and pure thought. But he is always extremely skeptical of any alleged fact that is in logical contradiction to his theory. The observations he makes must be relevant, not merely to the particular question in mind, but more especially to the stage the theory has reached in its own development.

For a scientific fact is always a fact in relation to a theory or a pattern. An idea is true scientifically only insofar as it is useful or expedient for the specific purpose of effecting an orderly organization of experience. A new experience is treated as real or true only if it is found to be organizable, that is, if it can be incorporated as a unit in the existing system of knowledge. However, if any experiment turns out contrary to expectation, that is, if it does not fit the pattern and that lack of fit is repeatedly confirmed, the pattern itself must be altered. Thus scientific progress is possible.

Of two given systems of experience, both of them internally consistent, yet mutually incompatible, the scientist selects as true the more extensive system, his only test of truth thereafter being coherence with that system. But, even to convict the senses of error in a given case, the scientist must assume that sense perceptions are true fundamentally; similarly, to convict reason of error, he must assume the broad validity of reasoning.

Ideally every science should be presented as a body of doctrine that can be shown to follow with rigorous, logical necessity from a relatively small number of original postu-

lates that have necessarily to be assumed to be true without proof. There should be the smallest possible number of such basic axioms. To "explain" a new fact or happening is to incorporate it in a logically integrated set of scientific propositions. Every science is based upon ultimate axioms which must be accepted as true sans proof.

Science thus offers us a pattern of truth. It maps the universe for us. The map is not the universe, but it helps us vastly in finding our way around in the universe without too much stumbling into disaster. It is a thought-and-labor-saving device. Science also acts as an evaluating mechanism in the sense that it aids us to measure the validity of other systems by comparison.

THE POWER INHERENT IN ABSTRACTIONS

Very often the knowledge that has proved most useful has been discovered by workers in science who concerned themselves primarily with trying to perfect the pattern of scientific truth, and thought neither of practical applications nor of financial reward. In his *Science and Method,* Henri Poincaré remarks how the triumphs of industry that have enriched so many "practical" men would never have seen the light if practical men only had existed. For the so-called practical man has always been preceded by what Poincaré called "unselfish devotees who died poor, who never thought of utility, and yet had a guide far other than caprice."

These conceptions, patterns, or maps the scientist evolves have definite utility, even monetary value. We naturally interpret the world pictorially, but our private picture may have little meaning. Science offers a more universalized picture, though one highly abstract in all fields. Yet abstraction is a source of political and economic power. Such abstractions are made, as was said earlier, by separating out or taking away certain elements of reality, or certain aspects of an event, and treating them as if they were the wholes. This method yields the scientist useful results though the abstraction never represents more than part of reality.

A farmer raises wheat or cotton. He does actual work. He feels, handles, lives with his crops, and we tend to think of him as close to reality and far from abstraction. He is, in a sense, closer to reality in performing direct manual operations. But a financier, whose dealings with this reality of cotton and wheat are as abstract as those of any physicist—even though he affects to regard himself as a very practical man—is actually more powerful than the farmer who raised the crops. He can deal with wheat and cotton abstractly, as figures on paper, without ever having seen either growing. His knowledge about price movements is abstract, but it has power.

The modern physicist works similarly. He knows nothing whatever of matter as the thing in itself. But he knows certain laws of its movements; he knows enough to manipulate it. After working through formidable strings of equations in which the esoteric symbols stand for things whose intrinsic nature he can never, never know, he arrives at a result that can be interpreted in terms of your perceptions and mine. It can be utilized to produce desirable effects in our lives.

A single important scientific generalization based on abstractions can carry the race far and save a great deal of fumbling around. George Stephenson invented a safety lamp for miners. He first made a kind of lamp he thought might do, then tested it, altered it, tried it, tested, altered, and tried again, and so on, until by this slow and tedious process he finally evolved a satisfactory lamp. That is the empirical method your inventor often uses.

But a gifted scientist, like Sir Humphrey Davy, worked differently on the same problem. Instead of proceeding from isolated facts to general principles, he started in the more economical way from a general

principle that science had established. This told him that explosive mixtures of mine damp would not pass through small apertures or tubes. Hence, if you made a lamp tight on all sides and containing only a small aperture for the admission of air, it would obviously serve the purpose. Such a lamp Davy produced. "Davy discovered a principle and then constructed a lamp based upon it. Stephenson made a lamp and was led by it to a principle."

Most investigators have to seek the solution of special problems before attempting to solve general problems. But they often pay a big penalty in needless experimentation through inability to handle time- and labor-saving scientific abstractions. The work of Luther Burbank as compared with that of a thoroughly trained scientific geneticist comes to mind as an example.

Moreover the purest of pure research, basic research undertaken merely to arrive at general principles—that is, to piece out a little more of the map we have utilized to symbolize the scientific pattern of truth—offers us knowledge of great value. Michael Faraday's discovery of electromagnetic induction was a triumph of pure reason to him, but it showed man how to harness electricity for heat, light, and power. An abstract mathematical equation devised by Clerk Maxwell gave us the radio and television, for Marconi was inevitable after Maxwell. Pure research, animated by plant explorers' curiosity, discovered cold-resistant alfalfa in Siberia, and Gibbs' abstract-phase rule underlies much modern metallurgy.

Though much pure knowledge is often abused or misapplied, humanity benefits enormously when rationally planned use of it can be assured. Yet it all springs from a system of what the ordinary person would call very unrealistic abstractions.

Research may be conveniently divided into four classifications:

(1) Background research with no practical objective consciously in view, like Mendel's work in genetics, research in molecular structure, in atomic physics, on photosynthesis, or in experimental embryology, or some investigations undertaken in anthropology.

(2) Basic or fundamental research that has a distant practical objective—soil science, meteorology, animal breeding, the industrial utilization of agricultural byproducts and crop surpluses, or studies of price movements, mortality rates, or shifts in population.

(3) Research carried on to attain an immediate objective or to solve some specific problem—for example, to wipe out some harmful insect or to eradicate some plant or animal pest, to raise farmer purchasing power, or to introduce the use of a new agricultural machine without economic disruption.

(4) Development or pilot-plant research, the type needed to translate small-scale laboratory findings into full-scale agricultural or commercial practice, such as testing out a new laboratory method for making sweetpotato starch, trying the food-stamp plan in a single city, or seeking to rehabilitate certain impoverished farm families by making them relatively small character loans.

Clerk Maxwell and Heinrich Hertz performed research of type 1 but gave the world the fundamental principles underlying all modern applications of electrical science. The equations they developed about 1873 concerned the relationships between electricity and magnetism and the detection of magnetic waves. Michael Faraday's work also was in the field of what is commonly called pure science, or what is classified here as background research.

Such workers as these are largely animated by curiosity and an urgent desire to extend the field of human knowledge. Yet to them we owe this entire vast system of technology and mechanics which forms our environment today. Obviously abstract

scientific knowledge is a far more powerful revolutionary force than the "radical ideas" which so often frighten us.

IS ONE SCIENCE BETTER THAN ANOTHER?

Scientific theories are, by and large, simply groups of related hypotheses, based on axioms and experiments, that permit our reasoning machines (minds) to interpret certain events around us rationally. This applies also in social science. While the evolution of a social or economic state of a particular kind is no more predictable scientifically than the actual discovery of atoms or electrons, we can record the laws that would apply in such a state, even though it does not exist.

Again, we can never affirm that a certain law in any science will or will not become operative. A man falls from a height; the law of gravity becomes operative; something intervenes, however, and another law becomes operative. A certain step is taken which should make the prices of agricultural commodities rise, but they fall. We cannot interfere with economic any more than we can with physical laws, but we can influence the situation to some extent and thus have a say as to which law becomes operative.

Social scientists have been fallaciously accused of lack of precision. That is largely because their method is not well understood even by themselves. It has been said that because they cannot tell what an individual unit—a human being—will do in a given situation, they are inept at prediction. But neither can the physicist tell what an individual electron will do, and the social scientist, after sufficient investigation, can do the same for the units with which he deals.

Nor could phenomena in any social science be more unstable than those in physical science. Astronomy unfolds to us worlds forming and dissolving; geology, continents rising and falling; biology, species appearing and becoming extinct; physics, infinitesimal particles in external motion.

NEEDED—A NEW SCIENCE TO MAKE USE OF SCIENCE

Though science as a whole has done much to promote research, it has done very little to supervise scientifically the utilization of the knowledge that research produces. We have no science for making use of science, though sociology would be such a specialty if it performed the functions we have a right to expect of it.

Sometimes scientific discoveries are quickly applied in commercial practice before sufficient controlled work has been done on them to assure us of their value. At other times the lag is long between the fully authenticated scientific discovery and its widespread application. Too often the fruits of research can be supplied only to the few who can afford to purchase them.

Some agency is needed the function of which is to oversee the entire process of applying research results in practice. Because we lack such an agency, confusion, disorder, and impoverishment tend to follow our unplanned, haphazard utilizations of scientific knowledge in commerce, industry, agriculture, and society generally. Thus, while originative scientific discoveries make many new jobs, intensive scientific discoveries abolish very many more.

Obviously, sensible provision must be made to organize the reciprocal relationship between research and society. There must be smoother functioning, with far less friction, to prevent or reduce shock and imbalance. This can be accomplished only by pure and applied research in economics, sociology, political economy, human ecology, cultúral anthropology, social psychology, and the social sciences generally. That, in turn, will mean a realization that all science is basically one.

THE SOCIAL IRRESPONSIBILITY OF SCIENTISTS

This brings us to the rigid compartmentalization that has done so much to sterilize scientific knowledge by depriving scientific specialists of broad social vision. So far the scientist has usually confined himself to making observations, formulating hypotheses, planning and carrying out experiments and further investigations to test his hypotheses, perfecting the hypotheses until he could enunciate a general principle or scientific law, and then stopping. Beyond that point he has professed little interest. Yet essentially the entire process must be carried on over again in the field of social science to apply the knowledge in practice scientifically.

In the past the research worker has left the process of applying the knowledge he produced to others who were poorly grounded in scientific method and who usually lacked the scientific spirit. He has taken little part in the formulation of broad plans and programs for the social good and almost none in making these programs effective. This is natural. Persons in all lines of activity tend to become compartmentalized. In the scientist's case this process is perhaps accelerated by the popular notion that every scientist is queer—an absent-minded-professor type not to be trusted to produce sound plans, not likely to have useful ideas. The work of Benjamin Franklin and many others sufficiently disproves this notion.

This has been very unfortunate. To be sure, the research worker must carry on objectively and without prejudice. He must seek to avoid bias and emotional disturbances while working creatively. But he must learn to do more than merely produce new knowledge. For one thing he must learn to express himself clearly; he is also responsible for the dissemination of knowledge. Furthermore he must to some extent be an interpreter, for his austere technical formulations of knowledge may be meaningless to others who must aid in making it socially effective.

EVILS OF OVERSPECIALIZATION

The specialist also frequently fails to see his own results in their proper perspective. He tends to be afflicted with the caste spirit. He fails then to understand the ordinary men and the politicians who must be in charge of the legislative and executive departments, though it is his duty to give them expert advice, and even in part to guide them. For they know usually what the people want and what they will not have. The specialist tends too much to measure life in terms of his own subject and often reveals himself as naïve when asked for his opinion on broad matters of policy.

The restricted, specialized outlook of scientific workers themselves has done much to hinder right relaltions between science and leadership. Few scientific specialists have progressive, intelligent opinions in fields outside their specialty. Very often they even lack the ability to express the results of their work in such manner as to contribute to the normal life and growth of the community.

Today scientific problems ramify into many fields. They are often to be solved only by teamwork on the part of several different kinds of specialists. Advances in one science also depend on those in another; thus for example, the understanding of the nature of viruses waited upon the invention of the high-speed ultracentrifuge. It becomes increasingly necessary that we have technical men, trained in two or more sciences if possible, to bridge the gap between specialties. Otherwise great opportunities will be missed.

Science must be unified even while it is departmentalized into special sciences. These must be considered arrangements of convenience, not actual cleavages. Each special science must be unified within itself and in relation to science as a whole.

Scientific language must be simplified and made more universally understandable, due attention being paid the denotative, or purely informational, and the connotative, or effective use of words. Scientists must know themselves when they are imparting information (making factual reports) and when their words reflect emotional states within themselves or seek to arouse them in others. Complicated formulas must be correlated with everyday life by translating them into common language.

A STUDY OF THE RELATIVE DIFFICULTY OF SCIENCE INFORMATION IN RELATION TO ITS FREQUENCY OF APPEARANCE IN TEXTBOOKS*

VICTOR C. SMITH
Ramsey Junior High School, Minneapolis, Minnesota

As part of a larger study, the problem arose as to how to validate the inclusion of a given item of information for study in a general science test. One of the standard methods of doing this is to make a survey of standard textbooks of the subject, and in some arbitrary way to use only those items which are found in a majority of books. Previous studies have indicated that there is no relationship between frequency of occurrence and difficulty of a test item.

In construction of the test, 725 items were of such nature that they could be found stated directly in the science texts, or if not stated directly, could be inferred easily from information clearly presented.

In the teaching experiment which was set up, these items were included in a test which was standardized by giving the test to 300 boys and 300 girls, all of whom were using one or more of the ten general science texts surveyed. It is assumed that these books were studied by the pupils, that the exposure to any given item was more or less random, and that the various teachers of the fourteen school groups tested emphasized information in no systematic manner. It must not be forgotten, of course, that general science is a recognized school subject with a fairly well standardized course of study.

A teaching experiment was set up in which about 1,500 items were taught intensively and exposed as uniformly as possible to determine their relative difficulty. These 1,500 items included the 725 used in this study. Every item was studied by every pupil in the experimental group. For the purposes of this study only pupils whose mental ages were in the span of 15 years to 16.99 years were used. Thus the group used was more homogeneous than the usual school class.

One difference in the make-up of the standardizing or random exposure group, and of the experimental or uniform exposure group, was that the former group included a large number of pupils from smaller towns, while the latter group was from a large city junior high school.

The assumption involved in attempting to solve the problem was as follows: If frequency of occurrence of an item in textbooks is an index to probability of a pupil being exposed to learning that item, the random exposure group should be able to equal the achievement of the uniform exposure group on those items found in all books, and as the frequency of occurrence of an item in texts decreased, the relative

* This is an abstract of portion of the Ph.D. thesis, *Factors Affecting Learning of General Science*, which is on file at the Library of the University of Minnesota. In this abstract, bibliography and tests of significance have been omitted for brevity.

success of the random exposure group, as compared to the uniform exposure group, should decrease in direct ratio to frequency of occurrence of items in the books.

Accordingly, per cent of right answers on each item was calculated separately for the two groups. The score of each item was per cent of pupils answering the question correctly. The scores of the random exposure group were subtracted from the scores of the uniform exposure group for each of the 725 items.

Several interesting observations may be made from this data.

1. Children somehow learn a considerable amount of general science even when not exposed to it in any systematic manner.

2. Material found in 9 or 10 of the ten books is more likely to be learned than is material found in 8 or fewer of the ten books.

3. For the 141 items found in all ten books, the uniform exposure group did little if any better (considering possible differences in mental ability) than did the random exposure group. Even on material found in nine of the ten books the uniform exposure group achieved only slightly better than the random exposure group.

4. In making tests, it is well to select material common to all or nearly all the books likely to be used, if the test is to be used to measure what pupils are expected to have learned as a result of their study.

5. A test including items from relatively few books is likely to add chance factors to the measurement of ability to learn.

6. There is a low but definite relationship between a pupil's relative success in learning a general science item and its frequency of occurrence in textbooks.

TABLE 1

SCATTERGRAPH OF DIFFERENCES BETWEEN SCORES OF UNIFORM EXPOSURE AND OF RANDOM EXPOSURE GROUPS, PLOTTED AGAINST NUMBER OF TEXTS IN WHICH ITEMS APPEARED

	Number of Textbooks in which Items Were Found											
Differences	0	1	2	3	4	5	6	7	8	9	10	Fy
60–69.9					1							1
50–59.9		1	1				1	1	2		1	7
40–49.9		3			1	6	3	1		2		16
30–39.9	1	1	2	5	5	4	3	9	5	5	4	44
20–29.9	2	1	7	6	7	11	17	14	16	15	8	104
10–19.9	3	7	10	6	13	11	18	24	35	24	29	180
0–9.9	1	2	6	8	12	9	12	30	43	47	45	215
—.001-—10			1	4	4	7	7	12	19	21	38	113
—10.1-—20							2	5	8	11	10	36
—20.1-—30							1			2	4	7
—30.1-—40											2	2
Fx	7	15	27	29	43	48	64	96	128	127	141	725
Mx	19.30	24.33	18.33	15.00	16.14	17.92	15.00	11.64	12.88	7.20	4.93	

Then a scattergraph (Table 1) was made, plotting these differences in scores against the number of books in which the items were found. The row Mx in this table is the average superiority of the uniform exposure group in each column of figures. That is, on items found in ten books, the uniform exposure group was only 4.93 per cent superior to the random exposure group.

To obtain a more exact estimate of the relation, the *eta* correlation was calculated from the data in the table. The correlation found was .32, which for 725 items and the number of cases used in this experiment, is a statistically significant correlation. That is, the correlation found could not have resulted from chance factors alone.

THE ACCEPTABILITY OF PHYSICAL SCIENCE AS A COLLEGE-ENTRANCE UNIT

ROBERT H. CARLETON

Chairman of Science Department, Public Schools, Summit, New Jersey

THIS article reports an investigation, the results of which are precisely what most—perhaps all—readers of this magazine would have predicted. For the past ten years Summit High School has had a course in Physical Science for the "non-college preparatory" group of students [1], and for the past five years the writer has been arguing the thesis that this course is likely to prove far more functional even for "college preparatory" students than the more traditional chemistry or physics; also, that Physical Science should be the recommended course, following Biology, for all students whose major interests are in non-science fields. The typical response of administrators and guidance counselors to this proposal is, "The idea sounds good, but Chemistry or Physics is needed for college-entrance credit; the colleges will not accept Physical Science." The results of this investigation show that in general, the colleges will grant entrance credit for any science course that the high school has seriously thought through and has included in its curriculum, and which the recommended college-bound graduate then presents as one of his entrance units. The writer hopes that a somewhat detailed report of this investigation may be helpful to others in their efforts to develop a more adequate program of science education for all the students in their schools.

The problem. The following question was submitted to the admissions officers of 95 colleges and universities: "Will your college or university grant entrance credit for the successful completion of the Summit High School course in Physical Science (as outlined in the enclosed Course of Study) when presented by applicants seeking admission to the non-scientific or non-technical curricula of your institution? This with the provision, of course, that the applicant meets other academic and personal requirements and carries the recommendation of the high school principal that he is capable of college-grade work."

Collection of data. The institutions to which the above query was submitted were selected to include, first, all the schools which Summit High School graduates have

TABLE I

SUMMARY OF SUPPLIES

	East				*Middle West*				*South and Southwest*			*Mountain and Pacific*			
Type of College	*Queries Sent*	*Approved*	*Approved with Favor*	*No Reply*	*Queries Sent*	*Approved*	*Approved with Favor*	*No Reply*	*Queries Sent*	*Approved*	*No Reply*	*Queries Sent*	*Approved*	*Approved with Favor*	*No Reply*
Teachers College	3	2	1												
State supported	6	4	2		6	4	1	1	6	6		2	2		
Private—men	14	10	3	1					3	2	1				
Private—women	14	5	5	4											
Private—co-ed.	17	9	5	3	7	3	1	3	5	3	2	2	1	1	
Catholic	3	1		1	2	1	1								
Junior college	3	1	1	1	1		1								
Canadian	1		1												
Totals	61	32	18	10	16	8	4	4	14	11	3	4	3	1	

entered during the past five years (83 schools), and second, a number of additional schools to complete the coverage of geographical regions and various types of schools. The distribution and classifications of these 95 institutions, together with the number of replies received, are set forth in Table I. As indicated in the table, 78 replies were received for a percentage return of 82.1 per cent.

The findings. Note in the table that there are no columns headed "Not Approved." The reason for this is that *every one of the 78 replicants gave approval, to some degree, to the proposal submitted to them;* that is, at least the 78 colleges replying to the query *will* give entrance credit for the course in Physical Science. A small number of these colleges stated that credit would be granted, but with certain reservations, while a much larger number sent replies expressing the approval and enthusiastic endorsement of their admissions officers and science department heads for the proposition submitted. Typical replies from both categories are given in the next two sections of this report in the belief that they shed further light on practical aspects of the problem as viewed by the colleges. (Parenthetical comments are the writer's.)

Typical reservations. "Although our Science Division feels fairly strongly that each student in the College of Arts and Sciences should be required to take a specific course in one of the sciences involving a good deal of actual laboratory work, we shall be very happy to grant full academic credit at entrance for your Physical Science course in the 11th grade."

"With us the amount of science that a student has to carry in college is based on the amount completed in high school. For such purposes general science is not counted, although it is accepted as an entrance credit, and I think that the status of the course that you propose in Physical Science would be similar."

"It has been decided that *X* College will give elective credit for this course although it would not be possible to substitute it for specific requirements in Chemistry and Physics. I am not inclined to agree that 'Physical Science is an analogous effort to do in the physics-chemistry-astronomy-geology field what Biology has done in the botany-zoology-physiology field.' The basic subject matter in the field of Biology is such that the combination mentioned above can readily be made. There is a definite interrelatedness in all of the biological sciences. This is not so true in the field of physical sciences."

"We shall consider this course as an elective unit, and shall not be willing to accept it to complete the Mathematics-Science requirement." (This means that Biology and Chemistry or Physics would be required.)

"While the admissions committee felt the objectives and plan of the course warranted credit for admission from high school, it did not feel that there was sufficient laboratory work to warrant its recognition as a *laboratory* science."

"I feel that Physical Science as given in many public school systems has not had a high standard and has received the treatment by the colleges that it deserves. This low standard is due in a large measure to the dearth of teachers adequately trained to teach general courses in the physical sciences."

"Elective entrance credit would be allowed for the course you suggest if the candidate offers also a unit in a regularly accepted field of science." (A unit in Biology would fulfill this reservation.)

"It occurs to me that ten to fifteen laboratory experiments is a rather small number. A student could hardly learn much about the laboratory method or of laboratory techniques with so few experiments." (The Course of Study submitted proposed "ten to fifteen individual laboratory experiments.")

"Since our college gives placement exams to all entering students, the proposed plan, from our point of view, will

depend entirely upon the effectiveness of its execution. If the proposed plan is merely a further concession of educational institutions to the students' efforts to avoid challenging problems, I should not like to see it undertaken. I should like very much to see some of the fundamental questions and concepts in the physical sciences rigorously considered. I should not like to see what meat there is in a conventional high-school physics or chemistry course sacrificed for a course in which there is no meat at all."

"We are willing to grant credit for your course in Physical Science if it is taken in conjunction with a laboratory science. In this case, it would be either chemistry or physics."

Typical expressions of endorsement. "We are very willing, indeed, to accept this course in Physical Science for the 'Philosophy and Aims' are well developed and clearly of great value to the non-scientific or non-technical applicant."

"The program of science outlined is in keeping with the recommendations now being made by certain college instructors of science as well as by science educators. A symposium, 'How can science education make its greatest contribution in the post-war period?' in the October and September issues of Science Education [2] is in general agreement with the Summit plan."

"It seems to us that this Physical Science course as suggested provides a good background for later more specialized work in science. Students should be provided in this way with the opportunity of gaining a perspective that will be much to their advantage in later work in science."

"Professor *X's* reaction is also favorable. He feels that such a course as you indicate would be good preparation for college work. His criticism of many of the present courses is that they give no real scientific training in the application of the scientific method. He feels that a general knowledge of the whole field of science would be of ultimately greater benefit than a little concentration on one subject."

"We have been doing this sort of thing for some time (that is, granting entrance credit for Physical Science). Your idea is a fine and commendable one."

"The Admissions Committee is always very much interested in learning about prospective changes in what at present are often somewhat inflexible programs of the secondary schools."

"The primary responsibility rests with the secondary school to determine the level of instruction. We have confidence that you will maintain proper standards in all college preparatory subjects so as to merit the confidence of future students as well as the colleges. The best of success in your efforts to further a worthwhile science program which at the same time makes a definite contribution to the proper preparation for college."

"The best way to answer your question is to say that, if an applicant has had a college preparatory course, we will accept as an admission credit any course which is acceptable to the high school for graduation."

"A good deal of research on our part has indicated that the specific subjects a student takes in high school is of far less importance than what he does with those subjects when he takes them."

"We would be willing to accept Physical Science as the only science even in the case of an applicant for admission to a scientific or technical curriculum provided his record indicated otherwise that it would be advantageous for us to grant him admission."

"Your plan seems to me to make great good sense. Please feel free to use this letter as an enthusiastic affirmative vote in behalf of what you are trying to accomplish."

"Education is due for a 'growing up' and your program of Physical Science meets with our enthusiastic approval. The 'education for life' is the important thing and

we feel that you have taken an important step forward."

"We are definitely in favor of experiments in methods of preparing students for college if they are made by reasonable and responsible people."

"Similar courses have been appearing on the records of applications for admissions for some time, and we feel sure they will continue. The University of *X* admits from high school any graduate of a standard secondary school, and accepts any courses which are accredited toward graduation by that high school."

"The head of our Physics Department in commenting on your outline says, 'I am *much* in favor of this course.' "

"I have had this material examined by Dr. *X*, head of our Physics Department, who is himself deeply interested in the educational philosophy which your proposal embodies. He feels that your move is a long step in the right direction."

It seems appropriate at this point to indicate the writer's belief that the proposal in question is reasonably in line with certain recommendations of the recent *Education for All American Youth* and the Harvard Report, *General Education in a Free Society* (although the writer cannot accept the aims specifically proposed for Physical Science in the latter report). Turning to pages 158–160 of the Harvard Report, we find the following expressions of the Committee's opinions; italics are the writer's.

"In high school science instruction should certainly continue. At this stage those who are properly qualified to do so should have the opportunity to pursue sciences and begin to develop the skills appropriate to them. But for those for whom secondary education is terminal, and possibly for all students, *a course in a particular science does not really fulfill the aims of general education.*

"As a second course in science, or as a first course for those whose training in general science is already adequate, a course in general biology is probably most advisable. . . . General biology, coming usually at the tenth grade, is probably the last formal science instruction that many students not going on to college will obtain. *Whatever they are going to learn of the scientific spirit and methods of accumulating knowledge* must be epitomized in this course.

"Those students preparing to enter college but who have no direct interest in the sciences might also stop at this point; or for those who have had biology in the ninth grade a further course in physics or chemistry might be advised. *Better still for such students would be a systematic presentation of basic concepts and principles of the physical sciences, such as is now being experimented with in a number of schools, . . . its primary aims should be those of general education, not the development of the skills and technical knowledge of the potential physicist and chemist.*

"Those who plan advanced work in science and mathematics in college should go beyond secondary-school biology to a year of chemistry or physics or both. An integrated course in physical sciences might be of particular value to such students. . . . When properly designed such a two-year sequence should make a greater contribution to the student's general education and his preparation for further study than separate one-year courses in physics and chemistry."

The appended bibliography and list of textbooks in Physical Science may prove helpful to others who are contemplating modifications in the science education portion of their curriculum.

Conclusions. 1. Colleges are inclined to be more liberal in the nature and variety of secondary-school courses which they will accept as entrance units than many secondary-school teachers, counselors, and administrators give them credit for. Colleges are likely to be less interested (within limits) in what courses a prospective stu-

dent took in high school than in what he did with those courses he did take, so long as the high school maintains reputable standards and is willing to certify the student as a likely prospect for college work.

2. Secondary schools may undertake curriculum modification and research with full confidence that the colleges will, in general, heartily applaud such efforts if they are carried on by responsible persons and high standards are maintained.

3. Secondary schools may, if they choose, revamp at least the science-education portion of their curriculum so as to place emphasis on "education for life" and "education for the student's next-step purposes" rather than to divide the curriculum arbitrarily into "college preparatory" and "non-college preparatory" courses.

4. There is still a considerable body of college-level opinion inclined to view with hesitancy, if not alarm, the tendency toward generalization in high schools. These persons favor a "rigorous treatment" of fundamental science questions and concepts, and fear that courses "with meat" will be sacrificed for courses in which there is "no meat at all."

5. If a school is hesitant or in doubt about introducing a generalized science course for college preparatory students fearing it may not be acceptable to the colleges, and if the findings of this study do not dispel such doubts, it would be well to submit the course and a complete explanation to at least the chief colleges which the school's graduates attend; this should be done prior to introducing the course.

6. Physical science as a recognized, laboratory course comparable in standing to chemistry and physics, or even biology, still has some distance to go to assure full respectability—even though the experienced teacher knows that a Physical Science course can be much stronger (or inferior, for that matter) than any of the others, depending on what objectives are sought and on the quality of instruction.

7. It seems that one factor necessary to establishing the respectability mentioned above is laboratory work. In all probability, the physical science course should be a laboratory course in which at least twenty or so standard-length laboratory experiments done on an individual basis are included, although it is generally conceded by science educators that the old question of "demonstration versus individual laboratory work" is again largely one of objectives and either method may be superior according to what objectives are sought.

8. It would certainly encourage science teachers to experiment and explore with new-type courses and would strengthen them in their relations with counselors and administrators, and would in turn strengthen the position of the latter two in their relations with parents and Boards of Education, if the colleges would indicate more clearly in their catalogs their more liberal interpretation of "Requirements for Admission." Usually the science fields from which entrance units may be offered are listed as biology, chemistry, and physics, and sometimes, physiography, botany, and zoology. The simple addition of "acceptable survey or orientation courses in the biological and physical sciences" would clarify the question a great deal, since counselors, students, and parents rely on the word-by-word statement of the catalogs.

The chairman of the Committee on Admissions in a large and reputable eastern college wrote, "We allow all sorts of subjects (some of them practically vocational), even your 'Radio' and 'Industrial Science,' or art, or music, or a few commercial subjects as a 'fringe.'" But if the science teacher, counselor, or principal, and the student and his parents do not know this from other sources, they can seldom find it out by reading the college catalog.

SUGGESTED BIBLIOGRAPHY

1. Carleton, R. H. "Physical Science for General Education, I, II, III." *The Science Coun-*

selor. No. 1:7; No. 2:48; No. 3:81; March, June, Sept., 1941.

2. Symposium, "How Can Science Education Make Its Greatest Contribution in the Post-War Period?" *Science Education,* 28:231–238, 282–288; Oct., Dec., 1944.

3. Taylor, L. W., Heil, L. M., and Schaefer, P. E. "Chemistry Instruction for Purposes of General Education." *Journal of Chemical Education,* 18:10–14; Jan., 1941.

4. Bigelow, Karl W., Havighurst, R. J., and Lark-Horovitz, K. "On the Teaching of the Basic Sciences." *American Journal of Physics,* 12, No. 6:359–362; Dec., 1944.

5. Lark-Horovitz, K. "Science in the Schools of Tomorrow." *School Science and Mathematics* (reprint), 636–650, 126–156, 1943.

6. Meister, Morris. "Emerging Problems in High-School Chemistry." *Journal of Chemical Education,* 21:610–614; Dec., 1944.

7. Brandwein, Paul F. "Four Years of Science." *Science Education,* 29:29–35; Feb., 1945.

8. Educational Policies Commission. *Education for All American Youth.* National Education Association, Washington, D. C., 1944.

9. National Committee on Science Teaching. *Science Teaching for Better Living.* American Council of Science Teachers, N.E.A., Washington, D. C., 1942.

10. National Committee on Science Teaching. *Redirecting Science Teaching in the Light of Personal-Social Needs.* American Council of Science Teachers, N.E.A., Washington, D. C., 1942.

11. Burnett, R. Will. "Educational Policy and the Science Teacher." *Science Education,* 29:40–44; Feb., 1945.

12. Smith, Lee Irvin. "Problems in Postwar Education. Training for Democratic Leadership." *Chemical and Engineering News,* 23:338–344; Feb. 25, 1945.

13. Bush, Vanevar. *Science — The Endless Frontier.* Report to the President of the Director of Office of Scientific Research and Development. U. S. Govt. Printing Office, Washington, D. C., 1945.

14. Report of the Harvard Committee. *General Education in a Free Society.* Harvard University Press, Cambridge, Mass., 1945.

15. Giles, H. H., McCutchen, S. P., and Zechiel, A. N. *Exploring the Curriculum.* Adventure in American Education, II. Harper and Bros., New York, 1942.

16. Chamberlain, Dean, Chamberlain, Enid, Brought, Neal, and Scott, William E. *Did They Succeed in College?* Adventure in American Education, IV. Harper and Bros., New York, 1942.

TEXTBOOKS IN HIGH-SCHOOL PHYSICAL SCIENCE

1. Carleton, R. H., and Williams, H. H. *Modern-Life Science.* J. B. Lippincott Co., Chicago, 1942.

2. Eckels, C. F., Shaver, C. B., and Howard, B. W. *Our Physical World.* Benj. H. Sanborn and Co., Chicago, 1938.

3. Eby, G. S., Waugh, C. L., and Welch, H. E. *The Physical Sciences.* Ginn and Company, Boston, 1943.

4. Nettels, C. H., Devine, P. F., Nourse, W. L., and Herriott, M. E. *Physical Science.* D. C. Heath and Company, Boston, 1942.

CONTRIBUTIONS OF INSTRUCTIONAL FILMS TO THE TEACHING OF HIGH SCHOOL SCIENCE *

II

OREON KEESLAR
Lieutenant, U.S.N.R., U. S. Naval Air Station, Pensacola, Florida

PART I of this article described in detail an investigation to determine the extent to which certain selected instructional films in science contribute, particularly by means of the unique and the specialized functions of the motion picture medium, to the realization of three of the major objectives of science education in the secondary schools. The twenty-four films selected for study were assumed to represent the best available in the field of science, since each had been listed as "excellent" in two outstanding film catalogs, a rating determined in both cases on the basis of several hundred panel and/or classroom appraisals of the films.

The 1734 scenes which made up the twenty-four films were analyzed critically in the light of carefully prepared evaluative criteria and the data thus derived were

* Part I appeared in the March, 1946, issue of SCIENCE EDUCATION.

appraised in an effort to achieve a valid measure of the excellence of the selected films as teaching tools in the science classrooms of our high schools.

FINDINGS AND CONCLUSIONS

1. *The chief functions now performed by the best motion pictures available for teaching science are (a) the provision of vicarious experiences by "bringing the world into the classroom" (i.e., action observable only vicariously), and (b) the depiction of unobservable action through animation.*

The data gathered in this study indicate that scenes falling in the two categories mentioned above amounted to 56.9 per cent and 23.1 per cent respectively of the total number of scenes serving unique functions, and constituted 27.6 per cent and 11.2 per cent respectively of all the scenes in the twenty-four films analyzed. The unique function ranking third in frequency of occurrence was *time-lapse photography,* representing only 9.7 per cent of the scenes serving unique functions and 4.7 per cent of the total number of scenes in the films.

TABLE I

SUMMARY OF DATA COLLECTED BY FILM ANALYSIS

Film Number	*Total Number of Scenes in Film*	*Number of Unique Functions Served*	*Number of Specialized Functions Served*	*Number of Contributions to Objectives*	*Number of Scenes with No Function or Contribution*
*1	28	26	0	1	2
2	49	16	3	1	31
3	61	21	13	4	27
4	86	35	1	3	47
5	43	23	1	5	18
6	55	57	5	0	3
7	102	83	0	1	18
8	52	23	8	10	21
9	52	26	1	13	24
10	115	88	0	0	27
11	70	41	2	5	26
12	28	23	4	4	5
13	81	72	0	5	8
14	87	2	8	0	77
15	52	25	6	5	19
16	51	29	2	6	18
17	100	82	1	0	17
18	35	42	0	8	6
19	110	0	14	0	96
20	110	14	9	0	87
21	120	7	53	0	62
22	91	26	15	0	50
23	90	29	0	10	60
24	66	49	0	12	15
Totals	1734	839	146	93	764
Medians	68	29	2	3.5	22.5
Averages	72.3	35	6.1	4.0	31.8
Ranges	28 to 120	0 to 88	0 to 53	0 to 13	2 to 96

* Table I is read thus: The first film, containing a total of 28 scenes, was found to serve unique functions in 26 instances, specialized functions in no instances, and to contribute to 1 major science objective. Two scenes served no function and made no contribution, as functions and contributions are described by the evaluative criteria.

2. *Several of the unique and potentially valuable functions of motion pictures are utilized far too little in films designed to teach science.*

Conspicuous among these are (a) scenes simplified by animation, (b) slow-motion photography, (c) sound recorded to reify the subject studied, and (d) instruction in a process or method of doing something. In the investigation here reported, scenes serving these functions comprised 0.0 per cent, 0.1 per cent, 2.2 per cent, and 2.7 per cent respectively of the total number of scenes in the films (see Table II).

3. *Photomicrographs of objects in motion are used extensively.*

Although only fifty-two such photomicrographs were found (3.0 per cent of the total number of scenes), one or more occurred in over half (i.e., fourteen) of the twenty-four films. The frequencies of occurrence of photomicrographs in the fourteen films ranged from one to twelve per film, with a median frequency of three.

4. *Miniature photography, which is exceedingly valuable as a means of depicting certain types of subject matter in science, is not utilized to the extent which seems justified.*

In spite of the fact that the scientific concepts dealt with in some of the films were of such a nature that miniature photography could have been utilized to advan-

tage, this specialized function was served by none of the 1734 scenes analyzed.

5. *The depiction of the human elements of science (i.e., of the personalities, attitudes, and methods of scientists at work) is limited largely to those films of the inspirational-dramatic type,* and hence are not being demonstrated as intelligently or as fully as their importance in science warrants.*

TABLE II

PERCENTAGE OF THE TOTAL NUMBER OF SCENES (1734) FOUND TO SERVE UNIQUE FUNCTIONS, SPECIALIZED FUNCTIONS, TO MAKE CONTRIBUTIONS TO MAJOR SCIENCE OBJECTIVES, AND TO SERVE NO FUNCTION AND MAKE NO CONTRIBUTION

Function or Contribution	*Number of Scenes*	*Percentage of Total*
Unique Functions:	839	48.4
Methods and Processes not Directly Demonstrable*..	46	2.7
Action Observable Only Vicariously............	477	27.6
Simplified Observable Action	0	0.0
Animation...............	194	11.2
Slow Motion Photography	2	.1
Time Lapse Photography..	81	4.7
Recorded Sound with Action	39	2.2
Specialized Functions:	146	8.4
Photomicrography.........	52	3.0
Miniature Photography.....	0	0.0
Human Elements of Science	94	5.4
Contributions to Objectives:	93	5.4
Scientific Principles	85	4.9
Elements of Scientific Method	8	.5
Scientific Attitudes	0	0.0
No Unique Function or Specialized Function, and No Contribution to a Major Science Objective:	764	44.1

* Table II is read thus: The total number of instances in which scenes were found to serve unique functions was 839. This represents 48.4 per cent of the total number (1734) of scenes to be found in the twenty-four films analyzed.

* Two distinct types or groupings could be observed in the selection of science films studied. The first of these might well be called the *informational-expository* type. It was devoted exclusively to the presentation of scientific subject matter, and was usually highly organized for that purpose only.

The second group might be named the *inspirational-dramatic type.* With one exception these films invariably dramatized the STRUGGLES of some scientist, usually in the field of medicine, to combat a dread disease or to overcome the mental inertia of a society which refuses to see the Truth because of bigotry or superstitious ignorance. Nearly all were narrated in the ringing, society-shaming style of John Nesbitt's series of story-telling radio programs known as "The Passing Parade."

Of the ninety-four scenes which served this specialized function, only one appeared in a film of the informational-expository type. Although the bearded scientist peering tensely at test tubes amidst a forest of miscellaneous glassware was often dramatized, these glimpses never seemed to serve any definite pedagogical end.

6. *There is good evidence that the best instructional films in science, as represented by the twenty-four selected films, may teach, or at least are fitted to teach, scientific principles.*

When the six films of the inspirational-dramatic type, in which the theme or subject-matter tended to preclude the possibility of developing understandings of scientific principles, were disregarded, it was found that sixteen of the remaining eighteen films went beyond the mere presentation of scientific information. In addition to furnishing mere facts, these films summed up the facts with generalizations which met the criteria for a scientific principle. These generalizations occurred in frequencies ranging from one to thirteen, averaging about five and one-third principles per film.

7. *The best available scientific films reveal no definite intention or attempt to teach scientific principles.*

No opportunity was provided in the films analyzed for *the observers* to generalize upon the facts presented. It seemed reasonable to infer that the prime objective of those who produced the instructional films studied was, quite simply, *to dispense information.* The narrator knew so much which had to be told. In the brief ten minutes which were at his disposal, he often had to discuss broad fields of subject matter quite

comprehensively, cramming large amounts of generalized information into a short space of time. Indeed the wordings of many of the generalizations stated by the narrators of films seemed to bear out the contention that the exemplification of a principle was *not* the film-maker's original intention, but rather that the principle had resulted quite accidentally, as an expedient in the interests of brevity.

No direct evidence was found in this study to indicate that the makers of films hold the elucidation of a scientific principle to be either a primary objective of science teaching or pedagogically valuable in itself.

8. *If the films here selected be representative of the best, then even the best motion pictures do not adequately provide for teaching the Elements of Scientific Method.*

No evidence was discovered which indicated that the producers of the films had been aware that the *method of inquiry* is a vital aspect of science. The motion pictures of the informational-expository type were invariably replete with scientific facts, but deficient in exposition of the method used to discover those facts. Only one producer (Dr. Anton J. Carlson of the University of Chicago) appeared to have recognized the desirability of teaching the Scientific Method in films in connection with scientific subject matter, and deliberately incorporated Elements of Scientific Method into his films. The inspirational-dramatic type of film naturally dealt almost exclusively with the "struggles" of scientists to solve problems, yet nowhere were their methods of problem-solving intelligently demonstrated.

9. *On the basis of the evidence found in this sampling, it must also be stated that no intention or effort to teach the Scientific Attitudes through the medium of the best instructional films available today is evident.*

The depiction of the human elements of science, which often involve both the scientific attitudes and scientific method, was confined almost exclusively to the inspirational-dramatic type of motion picture. Vivid illustrations of scientists' reactions to the troubles and problems encountered as they pursued their researches were frequently depicted on the screen. By an observer well versed in the scientific attitudes, these illustrations could have been used to teach the scientific attitudes directly. Also, the scientific attitudes were often implied by the contrast between the non-scientific attitudes of the "crowd" and the scientific attitudes of the scientist, whom the crowd invariably opposed. This contrast provided material which was appropriate and suitable for teaching scientific attitudes, since the student automatically identified himself with the scientist and resented the injustice and intolerance demonstrated by the crowd; yet no direct reference to any scientific attitude was found in any of the films analyzed.

In no instance was an attitude definitely indicated as being scientific or unscientific. Hence the awareness of the scientific attitudes depicted dramatically upon the screen probably reached the viewer's consciousness only in the vague formlessness of emotional stimulation, rather than in the form of clearly verbalized ideas. Consequently, since such evidence as is available strongly indicates that attitudes cannot be effectively inculcated incidentally or indirectly, it seems unlikely that these films would function to an appreciable extent in inculcating scientific attitudes.

10. *There is evidence, therefore, which indicates that the film producers not only fail to provide the means of achieving the most important objectives of science teaching to the extent possible through the motion picture medium, but that they also fail to use optimally the unique and specialized functions of which the medium is capable.*

Unique functions are served by about one-half of the scenes (48.4 per cent), and specialized functions by about one-twelfth

of the scenes (8.4 per cent) of the films' contents (see Table II). Furthermore, a little over a twentieth (5.4 per cent) only were found to contribute to one of the three major objectives of science teaching. Therefore, nearly half (44.1 per cent) of the contents of the twenty-four films served no unique or specialized functions and contributed to none of the three major objectives.

The fact that at least a part of this approximate half is needed in all probability to effect *continuity* in the film does not mitigate the deserved criticism that many potent means of effecting important outcomes in science teaching were not employed in these films to the extent that was practicable.

RECOMMENDATIONS

At least three great cultural achievements may be credited to scientists and considered to be part of the heritage which teachers of science are obligated to pass on to rising generations: (1) a generalized body of knowledge of the material world, (2) a definite method of inquiry by which that knowledge was accumulated, and (3) the habits and attitudes of mind which characterize the best scientists and greatly enhance their chances for success in their search for knowledge. In planning and producing future motion pictures in science, film-makers should make certain that their products are definitely designed to teach these three major components of science, and that optimal use is made of the unique and specialized functions of the motion picture medium for achieving these objectives.

BIBLIOGRAPHY

1. Keeslar, Oreon. *Contributions of Instructional Films to the Teaching of High School Science.* Unpublished doctoral dissertation, University of Michigan, 1945. Pp. 147–247.
2. Keeslar, Oreon. "A Survey of Research Studies Dealing with the Elements of Scientific Method as Objectives of Instruction in Science." *Science Education* 29:212–216, October, 1945. Also "The Elements of Scientific Method," *Science Education* 29: 273–278, December, 1945.
3. Caldwell, Otis W., and Curtis, Francis D. *Everyday Science.* Ginn and Company, Boston, 1943. Pp. 610.
4. *Selected Educational Motion Pictures: A Descriptive Encyclopedia.* American Council on Education, Washington, D. C., 1942.
5. Lemler, Ford L. *The Film Utilization Guide.* Bureau of Visual Education, University of Michigan, Ann Arbor, Michigan, 1942.

SCIENCE EDUCATION AND INTERNATIONAL UNDERSTANDING

MERVIN E. OAKES
Queens College, Flushing, N. Y.

IN New York City the Manhattan telephone directory contains a page and a half of entries beginning with the word "International." To be sure not many of these titles have to do with the promotion of international understanding, but the extent of this list is perhaps symbolic.

As this is being written, a radio commentator is announcing the organizing of a World Education League.

Narrow nationalism seems to be dwindling. This we live in is a world of change. It is becoming more and more *One World.*

Scientists and science teachers, particularly, are engaged in an area which has no boundaries. Let's look beyond the horizon.

Science education is in a strategic position for promoting international understanding. No doubt before long American science teachers can learn much from our Allies concerning science instruction. Reports on science teaching in other countries have been made during the past decade or two: Miller [80] (numbers in brackets refer to bibliography) describes its method and content in France; Kilander [72] made a comparative study of science in

the high schools of Sweden and the United States; Meier [79] in the elementary schools of the Germany of the early 30's; by contrast, Zeimer [12] describes a nature study lesson ten years later; likewise genetics twisted into racism is a main theme in the handbook for the Hitler youth [15]; again back in the 30's, Efron [41] compares the physical sciences here and in France and Russia; Jones [69], the elementary schools of the Orient; and Okada [93], at all levels, especially college, in Japan. Some inkling of the place of science education in Soviet Russia is given by Eve Curie [33]. She describes, for one thing, the thrilling sight of 200 officers and men of the Red Army, standing in the snow as they listened intently to a woman geologist telling of current research; and also, she gives details of the schooling of Smirnov, son of a glass factory worker, who is now an outstanding surgeon.

Science teachers can find help in making their work more effective in fostering international understanding by familiarizing themselves with the research of psychologists regarding attitudes toward other nationalities. Some of their techniques might be adapted for use in science classes. Harper [52] compares opinions and attitudes of European and American college students; Cherrington [27] concludes that, although it is not easy to accomplish, international attitudes can be changed, and proposes workable methods; Biddle [12], Likert [74], and Wrightstone [121] report similar studies; Scott [106] attempts to discover the causes of international antagonisms; the International Institute of Intellectual Cooperation [66] emphasizes textbook revision to minimize these tensions; *Education for Victory* [40] contains a study which finds that Cincinnati students hold 'good-neighbor' attitudes with only a few misconceptions; Watson [118] analyzes opinions regarding Orientals; and Campbell [20] describes world-mindedness in geography teaching.

In other subjects, teachers are alert as to international affairs. Naturally enough, many social science departments sponsor an International Relations Club. The science teacher might help arrange for one or more of their programs on International Science.

In English, Domincovitch [35, 36] and Hogan [56] describe literature on Latin-America for classroom use and the former also includes Russian literature. Are some of the items on science?

Does foreign language study foster desirable attitudes regarding international relations? This moot question is discussed briefly in the *Review of Educational Research* [99] p. 145, vol. 13, 1943. Educators are cited who would drop language study, other than the vernacular, from common school as having little social utility. The vocal section of the language teachers not only pick up the gauntlet but even ask for a bigger fraction of the curriculum. The trend, however is toward less. The case for other languages is presented in the N. S. S. E. 36th Yearbook, Part II [86], Chaps. XII–XXIII. To quote one sentence (p. 201), "As members of any national unit, we owe so much to other peoples that this very international indebtedness in the fields of science, art, music, literature, in fact in all categories of human and social endeavor, forms a part of every national development."

Now what about science teachers? Well, for one thing, we can give more attention to the history of science in connection with many of the phases of our subject. There are ever so many opportunities in the teaching of a science principle to refer to the discoverers in various countries who contributed to the development of our knowledge. A familiar example is our knowledge of the heavens: Ptolemy in Egypt, Ulugh Beg at Samarkand, Copernicus in Poland, Tycho Brahé in Denmark, Galileo in Italy, Kepler in Germany; Herschel, German-born musician, in England (discovered Uranas); Doppler in Prague (now Czechoslovakia), Adams in England, and Lever-

rier in France, Tombaugh and Shapley in the United States and scores of others.

A present-day illustration is the story of Penicillin [98]: It was discovered by Fleming, an English bacteriologist of St. Mary's in London in 1928; studied further in 1938 by Florey, an Australian, working at Oxford, one of whose associates was Chain, the brilliant Berlin-born Jew, a chemist; who obtained it in nearly pure form; clinical tests were made on human patients in 1941 by Drs. C. M. Fletcher and Mary Florey, while London was being bombed. Such minute quantities could be prepared that Florey came to this country, where in the Northern Regional Research Laboratory of the Department of Agriculture at Peoria, Ill., Moyer developed a much better culture medium, and Raper searched out better strains of *Penicillia;* Keefer, of Boston, directed tests on various types of infection; Stock of W.P.B. enlisted five universities and twenty-two pharmaceutical manufacturers during 1943 to engage in further research on how to get it into mass production—up to that time a total of one pound had been produced; Florey began treating wounded soldiers in Africa; by mid-'44 all military demands were satisfied and it could then be put to civilian use; by early 1945, 15 lbs. a day were made and the price reduced from $20.00 per 100,000 units to 95 cents; plants costing over $20,000,000 are now devoted to its preparation. Ratcliff calls the success against the germs of gas-gangrene, etc., " the greatest single victory man has ever achieved over disease."

Countless other instances of international cooperation in research may be found in the histories of science. See—[13, 28, 29, 30, 34, 53, 58, 67, 73, 83, 103, 110, 119, 120, 123], among others.

In the sciences, many groups are giving attention to international collaboration: The British Association for the Advancement of Science, at its Cambridge meeting in 1938, formed a new division " for the study of the social and international relations of science." (Cited by Lovell [75]. It has also (1942–1943) proposed an International Resources Office as one of the functional organizations within the Dumbarton Oaks framework. Its sister organization, the A.A.A.S. [1], in the same year passed a resolution that " Science is wholly independent of national boundaries and races and creeds, and can flourish only where there is peace and intellectual freedom," and supporting the holding of international science congresses.

The American Association of Scientific Workers [3] has an active International Relations Committee, Dr. Bart J. Bok, Harvard University, Chairman. It urges an International Scientific Office under the Economic and Social Council of the World Organization; it proposes a scientific attaché at each U. S. Embassy in other countries, who may also serve as a university lecturer or professor while there, with a staff of younger scientists both on the embassy corps and as exchange or visiting scholars; and it protests the dismissal and imprisonment of scientists and other scholars in Argentina because of their democratic views. The New York Chapter has a Committee on Latin-American Scientists and Students. There is also an Association of Scientific workers in England [6], in Canada [21], and in Australia, with active interest in post-war policies for science.

The famous biochemist, Joseph Needham, Head of the British Scientific Mission in China, also proposes [90, 91] an International Science Cooperation Service to function in the United Nations Educational, Scientific, and Cultural Organization, with special emphasis on help to scientists in countries where science is relatively undeveloped. Its functions are tentatively defined as:

(a) Promotion of scientific cooperation in all aspects;

(b) Collection and dissemination of scientific information;

(c) Furtherance of schemes of research collaboration;

(d) Facilitation of movement of scientists across national boundaries;

(e) Provision of scientific advice to governmental and diplomatic personnel;

(f) Provision of scientific assistance to other international organizations.

These were later expanded into a set of 13 aims.

During wartime the United Nations set up Science Cooperation Offices in each other's capitals to deal with emergency exchange of scientific and technical information bearing on military affairs. Other international scientific bodies, several existing for some time, include: the International Council of Scientific Unions; the United Nations Standards Coordinating Committee; the World Power Conference; the United Nations Food and Agriculture Organization; the International Locust Control Commission; the International Fisheries Boards; the International Health Organization; etc.

The National Research Council [85] has a Division of Foreign Relations "to provide for international relationships, to promote cooperation, and to prepare and publish annually a concise summary of American activities in international scientific and technical organizations,"—and it publishes a list of international scientific congresses. Extensive summary is given by Cannon and Field [21-a].

The National Academy of Sciences [84] in 1944 held a Conference on Problems of Renewing International Scientific and Scholarly Cooperation.

The Smithsonian Institution [111], endowed by an Englishman and called by its first director, Joseph Henry, "the incubator of American science," maintains an International Exchange Service of government documents and scientific publications.

The Rockefeller Foundation [100] operates on a world-wide basis, especially in the International Health Division and its research fellowships. In addition, the Institute of International Education [64] in its annual reports, lists the many exchange and visiting students whom it supervises, several specializing in science. Science teachers are quite naturally interested in extending the interchange of students and teachers with other countries. There is a Committee for Inter-American Scientific Publications of which Harlow Shapley of Harvard is Chairman. The American Council of American-Soviet Friendship has a strong Science Committee, L. C. Dunn, Columbia University, Chairman, recently renamed the American-Soviet Science Society. V.O.K.S., the Soviet Society for Cultural Relations with Foreign Countries, has offices in Washington, D. C., and frequently issues bulletins (in English) concerning scientific developments in the U.S.S.R.

Besides these organizations, another agency outstanding for its work in disseminating records of scientific developments during recent hostilities was the U. S. Office of War Information. It is understood that the OWI gave world-wide circulation to monthly news-letters in each of many science fields, such as, Chemistry, Genetics, Geology, Mechanical and Electrical Engineering, Mining and Metallurgy, Medicine, Physics, Veterinary Science, etc., also a series of handbooks on developments and trends in American Agriculture, American Industry, etc. These all went to laboratories, libraries, scientific and trade magazines, and research workers. In addition there were various popular outlets, including a science clip-sheet once a month, science picture series, as well as science broadcasts. In many countries, these were the only sources of information available on recent advances in science.

Limitations of space forbid adequate discussion of them, but among the numerous problems and issues with international implications of which science teachers may well become more aware, the following may be listed:

1. The further extension of science instruction in the lower grades of elementary

school: Sarton [103] states, "Some amount of scientific knowledge should be taught to boys and girls of all ages." The matter is also discussed by Craig [86], Burnett [17], Huxley [61], Lovell [75], and many others.

2. What is the ordinary man's picture of science? Although all use the products of science, few understand it or use it in their thinking. Only one study along this line seems to have been made [76] and that was in England. Its authors say, "The gap between science and everyman is particularly noticeable, and is now one of the main problems of the survival of our civilization." Astrology on the news stands, hysteria resulting from a radio invasion from Mars, belief in prenatal determination of birthmarks and fear of lightning and that fear of snakes is inborn, gullibility in purchasing nostrums, skin 'foods' and the like—are a few of the symptoms. A study, similar to a 'Gallup Poll,' in this country would no doubt be very revealing.

Haldane [49] points out that although Western civilization rests on applied science, its ideas are still largely pre-scientific, which is "one of the principal reasons for the extraordinary misuse of applied science which is so characteristic of our age." Then, stating that most governments of the past and present by their general policy have prevented new applications of science either to life or to industry, he concludes that, "The problem is to promote a society with scientific ideas while ensuring independence of thought for the scientific researcher." And Lovell [75] put it, "The appearence of science as a mystical god to the ordinary man is not the least of the problems which civilization has to face, for with its removal will pass one of the high roads to frustration." Also he says, p. 140, "Science speaks a universal language which all can understand but to which few have listened." Sears [109], "Many of the difficulties with our ways of living are blamed on science . . . when the real difficulty lies within ourselves—in the way we use science for some things, and not for others." Crowther [31], "As Clerk-Maxwell foresaw, one of the tasks of the scientist is to see that the non-scientific public is not misled in the name of science." That "Science Is Not Magic" is presented by Hockett [55]. Every science teacher can contribute to international understanding by furthering the removal of this type of misconception.

3. The dependence of man on his environment, including the intelligent use of natural resources (so-called 'Conservation'): Stuart Chase [25] calls it "Nature's bookkeeping." A book for science teachers by Sears [107] is most valuable; others, Ilin [63], Muelder [82], Peattie [95] are recommended. Several optimistic reports are available: Mather [77] asserts, "The critical question of the 20th Century: How can 2 or 3 billion human beings be satisfactorily organized for the wise use and equitable distribution of resources that are abundant enough for all, but are unevenly scattered over the face of the earth?" may be answered, "Mother Earth can nourish every man in freedom."

Rorty [101] and Orr [94] urge that the science of nutrition *can* give us the needed vitamins and minerals in our regular foods if society utilizes the scientific knowledge being made available. Garrett [42] concludes that chemistry in making synthetics is rapidly making mankind less dependent on natural raw materials, thus reducing the necessity for world trade. He says, "The disparity between what we know and what we do is the supreme tragedy." However, Sax [104] challenges Mather's discarding the Malthusian doctrine; and Feis [42] disagrees with Garrett. He says, "The alchemist's empire has ever been more world-encircling. . . . The race between international politics and scientific inventions grows more perilous and its outcome more vital." Many science

teachers are successful in presenting this issue to their classes.

4. The Meaning of Science and of the Scientific Method (closely related to No. 2 above): It is both interesting and important to note that most of the definitions of science and the analyses of scientific method have been made by philosophers and others, not by scientists themselves. Notable exceptions are Wm. George, *The Scientist in Action* [43] and Waddington, *The Scientific Attitude* [116]; Barry, *The Scientific Habit of Thought* [8] also is worthy of mention, as are many other references. Science teachers should be leaders in clear thinking here above all.

5. More use of the History of Science: (referred to previously), not only for instances of international collaboration but for clear-cut examples of what scientists actually do—which is probably better than any definition of scientific method could be.

6. What are the relations between Science and Society? One point of view is that the progress of science depends on its fulfilling the needs of society. Its proponents include: Bernal [10], Crowther [31], Hogben [57, 58], Huxley [59], Needham [89], Orr [94], and Waddington [116]. They also insist that planning of research is necessary—planning in terms of human needs. P. M. S. Blackett, in *The Frustration of Science* [50], points out that heretofore "planning usually meant restriction of output in order to maintain prices," and Stern [112] decribes other restraints imposed on the use of the products of scientific development. Lovell [75], p. 72, sums it up, "Science thus takes on the aspect of a cork on a rough sea—it is both supported by society and buffeted by its waves." Chase [26] insists that modern technology and social controls can work together.

On the other hand, is the view that planning will deprive scientists of their freedom: thus Baker [7], Polanyi [97], and Taylor [114] have organized a *Society for Freedom in Science*. Their position has been compared to so-called *laissez faire* in economics.

Here is a task for science education to give aid in resolving this dilemma. Because of their specialized knowledge, it is the responsibility of science teachers to use their competence to help students use both facts and scientific method in solving their individual and community problems.

7. The Social Responsibilities of Science Teachers: (indicated in the preceding paragraph) Burnett [17] finds that science teachers agree with research scientists that they should be under no outside restrictions as to the type of endeavor their research represents if society is to secure the greatest benefits. Over 80 per cent of the teachers he studied agree that "an important function of science education is to deal with present unsolved problems and to offer science's best evidence in these problems . . . and to face such issues squarely in their teaching." Yet, "In spite of this professed belief . . . [many] are avoiding controversial areas in their teaching which represent areas in which young people must, or are extremely likely to, deal." Reasons most frequently given are: a feeling of their inadequate preparation, the immaturity of the pupils, and opposition of parents.

8. What is the Meaning of Race? The issue which, next to sex-education, is stated by these teachers to be most often avoided is that of racial prejudice. (Included above in studies of attitudes by psychologists.) What are the known facts from the study of heredity and anthropology? Brennecke [15] gives the answer of the Nazi 'master race.' Why not let our science students compare this answer with the evidence presented by Benedict [9] and by Sears [109]? A few references for teachers: Chaimas [24]; contrast, Cahill [14]; Haldane, Chap. V [47]; Huxley, pp. 201–222 [61] and Chap. IV [60], who recommends that we discard "the question-begging term 'race' . . . and substitute the noncommital phrase 'ethnic group'?"

9. Are Science and the 'Humanities' to be kept separated or are they to be truly integrated for understanding the world in which we live? For convenience it is useful to refer to 'scientific' and 'cultural' parts of the curriculum, but all too often the terms are used as though they were antithetical. Science is an integral part of our civilization (=culture). Sir Richard Gregory, in his essay, "Cultural and Social Values of Science" [74], discussing the place of science in education, has this to say, "The cultural claims of science rest on the social fact that the use and misuse of science intimately affects the every-day life of every citizen in a modern community." Shotwell [86] asserts that Science *and* History are the "keys to understanding international relationships. For all history teaches that self-knowledge comes chiefly from knowledge of others, especially of those whose characteristics vary more or less from ours. Contrasts and perspective are essential for clear thinking; otherwise routine and habit block the pathway of inquiry." Others than science teachers realize the inseparability of science and culture.

10. Science and General Education: Both Barry [8] and Kandel [70] warn against specialization. Science students need the liberal arts (i.e. cultural part of their education), and those in the arts (including social and literary fields) are depriving themselves of an important part of culture if science is neglected in their education.

Are science teachers prone to neglect scientific method in regard to science teaching itself? So we hear. It is questioned whether the courses for preparing science specialists also serve the best interests of arts students. The evidence for one solution is presented in the three chapters cited from Johnson [68]. "Experiment is the final test."

11. Threatened Shortage of Scientific personnel in the United States: discussed by Grundfest [45], Trytten [115], and Bush [18]. The latter italicizes the statement, *"With mounting demands for scientists both for teaching and for research, we will enter the post-war period with a serious deficit in our trained scientific personnel."* A fuller quotation presents the evidence:

"In my opinion, however, we may have drawn too heavily for non-scientific purposes upon the great natural resource which resides in our trained young scientists and engineers. For the general good of the country too many such men have gone into uniform, and their talents have not always been fully utilized. With the exception of those men engaged in war research, all physically fit students at graduate level have been taken into the armed forces. Those ready for college training in the sciences have not been permitted to enter upon that training.

"There is thus an accumulating deficit of trained research personnel which will continue for many years. The deficit of science and technology students who, but for the war, would have received bachelor's degrees is about 150,000. The deficit of those holding advanced degrees—that is, young scholars trained to the point where they are capable of carrying on original work—has been estimated as amounting to about 17,000 by 1955 in chemistry, engineering, geology, mathematics, psychology, and the biological sciences.

"Confronted with these deficits, we are compelled to look to the use of our basic human resources and formulate a program which will assure their conservation and effective development."

In this report to the President, Bush as Director of the Office of Scientific Research and Development (OSRD), proposes a government financed National Research Foundation, with five branches:

a. Division of Medical Research;
b. Division of Natural Sciences (physical and biological);
c. Division of National Defense (long-range);
d. Division of Scientific Personnel and Education (scholarships);
e. Division of Publications and Scientific Collaboration (including promoting international exchange of scientific information).

Its functions include:

"To promote the dissemination of scientific and technical information and to further its international exchange;

"To support international cooperation in science by providing financial aid for international meetings, associations of scientific societies, and scientific research programs organized on an international basis."

This plan has been embodied in a bill recently introduced by Senator Magnuson. The entire report deserves careful study by all science teachers.

Along similar lines, though on a small scale, is the Annual Science Talent Search, conducted by Science Service, Watson Davis, Director, and financed by Westinghouse (described by Edgerton [38, 39]); also the recently announced RCA science scholarships.

12. What are the Objectives of Science Teaching? Numerous lists have been proposed; two from Bernal [11] are quoted here:

"In the new view, training in science is required for two purposes:

"The first objective is *to provide enough understanding of the place of science in society to enable the great majority that will not be engaged actively in scientific pursuits to collaborate intelligently with those who are, and to be able to criticize or appreciate the effect of science on society.*

"The second objective, which is not entirely distinct, is *to give a practical understanding of scientific method, sufficient to be applicable to the problems which the citizen has to face in his individual and social life.*

"It is this latter objective that has been so completely neglected in the science teaching of the past, and which now requires the greatest thought and attention. What we have to do is to get across, no longer a certain number of scientific facts, but what may be called the operative content of science. The amount of knowledge needed for doing things is kept alive and memorable because it is constantly being used. With the operative content, and inseparable from it, should be the method of science which includes both the aspects of discovery and criticism."

And Burnett [17] discusses the preparation of science teachers: he urges that science teachers need something other than the formal specialized sciences—physics, chemistry, botany, zoology, etc., since they are arranged primarily for future research scientists—which he designates "more functional areas," that is, functional in science instruction. He cites as examples of such areas the following: life and environment, human growth and development, reproduction and sexual responsiveness, the nature of the physical universe and its changes through time, human nature; the production, distribution, and use of materials and energy; general and physical anthropology, phases of human physiology, communicable diseases, etc.; and continues, p. 54, "Yet there appears to be little opportunity through college education for teachers to gain expertness in the analysis of the ecology of their community (the housing problems, urban and rural relationships, etc.), the nature of the social, economic, and racial groups with which they work and live, the philosophy and history of science, and formal methods of inquiry into truth. Propaganda analysis, consumer education—a host of functional fields exist in potentiality which would develop largely the same order of technical expertness in the teacher of science as do the present fields of specialization, and which at the same time would fit him more adequately for his work and life in the community."

Such "areas" are of world-wide significance.

To sum up: We are living in times of tremendous changes, a world revolution, as Julian Huxley puts it, and science instruction can and must contribute mightily to international understanding. "The art of putting correct questions to nature is learned only gradually." "Science is still an adventure." (Sullivan [113]).

BIBLIOGRAPHY

1. American Association for the Advancement of Science. *Summarized Proceedings, 1934–1940.* Washington: A.A.A.S. 1940.
2. American Association of School Administrators. *Morale for a Free World: America and Not America Only.* 22nd Yearbook. Washington: National Education Association. 1944.
Science, pp. 216–217.
3. American Association of Scientific Workers. 28 Washington Square, North, New York City. "Program for Postwar Development of Science in the U. S." and *Science from Shipboard.* 268. Washington: Science Service. 1943.

4. American Council of Learned Societies. Washington, D. C. *Bulletin,* No. 33, Oct., 1941, p. 20.
5. *American Review of Soviet Medicine.* (For the exchange of medical information). Published by the American-Soviet Medical Society, 130 West 46th St., New York City 19. Bi-monthly. Editor, Henry E. Sigerist.
6. Association of Scientific Workers. 73 High Holborn, London, WC-1, England. "The Development of Science." Pamphlet on history of science.
7. Baker, John R. *The Scientific Life.* 154 p. New York: Macmillan. 1943.
   esp. Chap. 2. "Scientists as People."
   Chap. 9. "People as Scientists."
   Also *Science and the Planned State.* 120 p. Macmillan. 1945.
8. Barry, Frederick. *The Scientific Habit of Thought.* 358 p. New York: Columbia University Press. 1927.
   esp. Chap. IV. "Scientific Humanism: a Corollary."
9. Benedict, Ruth and Gene Weltfish. "The Races of Mankind." 32 p. Public Affairs Pamphlet, No. 85. New York: Public Affairs Committee. 1943.
10. Bernal, J. D. *The Social Function of Science.* (What Science Does; What Science Could Do.) 482 p. London: Routledge & New York: Macmillan. 1939.
    esp. Chap. VIII. "International Science."
    Chap. XIV. "Science in the Service of Man."
    Chap. VII "Science and War."
    Appendix VI. "The Organization of Science in France."
    Appendix VII. "Science in the U.S.S.R."
11. ———— "Science Teaching in General Education." *Science and Society.* Vol. IV, pp. 1–11, Winter 1940. Reprinted in *Science Education,* Volume 29:233–240, December, 1945.
12. Biddle, William W. "The Relationship between Knowledge and a Measure of Autistic Thinking on Certain International Problems." *Jl. of Soc. Psychol.,* 2:493–496, November, 1931.
13. Bliven, Bruce. *The Men Who Make the Future.* 325 p. New York: Duell, Sloan, & Pearce. 1942.
    esp. Chap. 15. "A Prescription for Humanity."
    P. 287, Sec. "Science Must Be Universal."
    Chap. 16. "Science and Civilization.
14. Boyd, T. A. "Charles Franklin Kettering." (Director, General Motors Research Laboratories and President, A.A.A.S.) *Scientific Monthly,* 60:85–88, February, 1945.
15. Brennecke, Fritz. *The Nazi Primer.* (Official Handbook for Schooling the Hitler Youth.) 280 p. Translated by Harwood L. Childs. New York & London: Harper. 1938.
16. British Association for the Advancement of Science. "The International Council of Scientific Unions." Sir H. Lyons. *Advancement of Science,* Annual Report, 2:178, 1942.
    Committee on Science and its Social Relations, active 1938–1940.
17. Burnett, R. Will. "The Opinions of Science Teachers on Some Socially Significant Issues." (A Survey of Teacher Opinion and Its Implications for Teacher Education.) 63 p. New York: Bureau of Educational Research in Science, Teachers College, Columbia University. November 1940.
    esp. Chap. III. "Teachers' Opinions on Racial Differences."
    Chap. VII. "Teachers' Opinions on the Control of Scientific Research."
18. Bush, Vannevar. *Science, the Endless Frontier.* (A Report of the Director of the Office of Scientific Research and Development to the President on a Program for Postwar Scientific Research.) Washington: U. S. Government Printing Office. July, 1945.
19. Cahill, Daniel J. "Some Thoughts on Intercultural Education." *High Points.* 26: 5–20, October, 1944.
20. Campbell, Don W. "Can World-Mindedness Be Influenced by Incidental Teaching? *Journal of Geography.* 33:266–271, October, 1934.
21. Canadian Association of Scientific Workers. Foreign Correspondent, Norman Veall, 2870 Van Horne Ave., Montreal 26, Canada. "Post-War Policy for Science." 1945.
21-a. Cannon, Walter B. and R. M. Field. "International Relations in Science." Waltham, Mass.: *Chronica Botanica,* 9: 253–298, Autumn, 1945.
22. Carnegie Endowment for International Peace. 405 West 117th St., New York City 27. *International Conciliation.*
    No. 385, December, 1942. Pp 459–536. J. P. Chamberlain. "International Organization."
    No. 396, January, 1944. "The Interdependence of the Modern World: Scientific Change." Pp. 97–101, and Education in World Peace." Pp. 687–695. Henry W. Holmes.
23. Carnegie Institution of Washington. *Yearbook.* No. 42, 1942–1943, Office of Publications and Public Relations. *Cooperation in Research.* 1938 "The Scientific Basis of the History of Science." Pp. 465–481. George Sarton.

24. Chaimas, Herbert M. "Race Conflict Challenges the Schools." *High Points,* 26:5–16, February, 1944.
25. Chase, Stuart. *Rich Land, Poor Land.* (A Study of Waste in the Natural Resources of America.) 361 p. New York: Whittlesey House. 1936.
esp. Chap. IV. "Nature's Bookkeeping."
Chap. XIV. "Planning with Nature."
Chap. XIX. "To Save a Continent."
26. ———— Men at Work. 146 p. New York: Harcourt, Brace. 1945.
27. Cherrington, Ben M. *Methods of Education in International Attitudes.* 123 p. Contribution to Education, No. 595. New York: Teachers College, Columbia University. 1934.
28. Christy, Arthur. *Asian Legacy and American Life.* 276 p. New York: John Day. 1945.
esp. Chap. 4. "Our Agricultural Debt to Asia."
29. Crowther, J. G. *Men of Science: British Scientists of the 19th Century.* 332 p. London: Kegan Paul. 1935, and New York: Norton. 1936.
30. ———— *Famous American Men of Science.* 414 p. London: Kegan Paul, and New York: Norton. 1937.
31. ———— *The Social Relations of Science.* 665 p. New York: Macmillan. 1941.
esp. Sec. 83. "The Social Responsibilities of Scientists."
32. ———— *Science and World Order.* 142 p. Harmondsworth, Middlesex, England and New York: Penguin. 1942.
33. Curie, Eve. *Journey Among Warriors.* New York: Doubleday, Doran. 1943. Pp. 228–239. Visits to Russian scientists.
34. Dampier-Whetham, W. C. D. *A History of Science.* 514 p. New York: Macmillan. 1931.
35. Domincovitch, Harry A., Chairman, Committee on International Relations, Council of Teachers of English. "Latin-American Literature for the English Classroom." *English Journal,* 31: 590–597, October, 1942.
36. ———— "Russian Literature for the English Classroom." *English Journal,* 31:699–707, December, 1942.
37. Editorial: "The Dissemination of Scientific Information." *Nature,* 154: 649, 1944.
38. Edgerton, Harold A. and Steuart H. Britt. "How Science Talent Winners Were Chosen." *Science News Letter,* 42:54–55, July 25, 1942.
39. ———— "Third Annual Science Talent Search." *Science,* 99:319–320, April 21, 1944.
40. Education for Victory. "Measuring Hemisphere Solidarity and Student Morale in Wartime." (Attitude toward South America.) *Education for Victory,* 1:19, May 15, 1942.
41. Efron, Alexander. *The Teaching of Physical Sciences in the Secondary Schools of the United States, France, and Soviet Russia.* 296 p. Contribution to Education, No. 725. New York: Teachers College, Columbia University. 1937.
42. Garrett, Garet. "Is World Trade an Illusion? The Age of Alchemy," and Herbert Feis and Thomas L. Finletter. "Alchemy—Master or Servant?" *Atlantic Monthly,* 171: 41–54, January, 1943.
43. George, William H. *The Scientist in Action.* (A Scientific Study of his Methods.) 354 p. New York: Emerson Books 1938.
44. Gray, G. W. *Science at War.* 296 p. New York: Harper. 1943.
45. Grundfest, Harry. "The Scientists' Postwar Problems." *Scientific Monthly,* 60: 130–140, February, 1945.
incl. sec. on "International Collaboration."
46. Haldane, J. B. S. *Science and Human Life.* 287 p. New York and London: Harper. 1933.
47. ———— *Heredity and Politics.* 202 p. New York: Norton. 1938.
esp. Chaps. V and VI. "The Nature of Racial Differences."
48. ———— *Adventures of a Biologist.* 281 p. New York and London: Harper. 1940.
esp. Chap. XV. "Blood Royal."
Chap. XVIII. "Society as a Biological Experiment."
49. ———— *Science in Peace and War.* 299 p. London: Lawrence & Wishart. 1940.
esp. Chap. III. "Soviet Science."
50. Hall, Sir Daniel and others. *The Frustration of Science.* 144 p. New York: Norton. 1935.
51. Hansen, Alvin H. *America's Role in the World Economy.* 197 p. New York: Norton. 1945.
esp. Chap. II. "The Economic Basis of Sound International Relations."
Chap. III. "The Need for International Economic Cooperation."
Chap. XI. "The Food and Agricultural Organization of the United Nations."
Chap. XXII. "International Collaboration *vs* Economic Isolation."
52. Harper, Heber R. *What European and American Students Think on International Problems.* 255 p. International Institute Studies, No. 12. New York: Teachers College, Columbia University. 1931.

53. Harvey-Gibson, R. J. *Two Thousand Years of Science.* (The Wonders of Nature and Their Discoverers.) 508 p. New York: Macmillan. 1931.
esp. Pp. 467–482. "Chronological Table of Discoveries."

54. Hill, A. V. "Organization of Scientific Research." *Science and Culture,* (Monthly journal devoted to natural and cultural sciences.) Calcutta: New York representative, American Geographic Society, 9:308 ff., 1944.

55. Hockett, Robert C. "Science Is Not Magic." New York: Sugar Research Foundation. 1945.

56. Hogan, Marita and Margaret Yeschko. "Latin-American Countries in Children's Literature." *Elem. English Rev.,* 17: 230–234, 256, 276–284, October and November, 1940.

57. Hogben, Lancelot. *The Retreat from Reason.* (Conway Memorial Lecture.) 82 p. London: Watts. 1936.

58. ———— *Science for the Citizen.* (Second of the Primers for the Age of Plenty.) 1,101 p. New York: Knopf. 1938.
esp. Pp. 1063–1076. "The New Social Contract."
Chaps. IX-XV. "The Impact of Science on Society."

59. Huxley, Julian. *Science and Social Needs.* 287 p. New York and London: Harper. 1935.
esp. Chap. IX. "Science and War."
Chap. X. "Man and Society."
Chap. XII. "Science and International Needs."

60. ———— *The Uniqueness of Man. (Man Stands Alone.)* 297 p. London and New York: Harper. 1941.
esp. Chap. IV. "The Concept of Race."
Chap. XI. "Science, Natural and Social."
Chap. XIII. "Scientific Humanism."

61. ———— *On Living in a Revolution.* 242 p. New York and London: Harper. 1942. Besides the one of the title, other valuable essays in this volume include: "Economic Man and Social Man;" "Philosophy in a World at War;" "War as a Biological Phenomenon;" "Colonies in a Changing World;" "Reconstruction and Peace;" "*Race* in Europe; and "Education as a Social Function."

62. ————"A Scientist Goes to Russia." *New Republic,* 113:125–127, July 30, 1945.

63. Ilin, M. (Pseud. of I. I. Marshak). *Men and Mountains.* (Man's Victory over Nature.) 330 p. Philadelphia: Lippincott. 1935. London: Routledge. 1937.

64. Institute of International Education. *22nd Annual Report of the Director.* New York: The Institute. October 1, 1941.

65. Institute of Pacific Relations. 1 East 54th St., New York City. Numerous publications.

66. International Institute of Intellectual Cooperation. *School Textbook Revision and International Understanding.* 192 p. Paris: The Institute. 1933.

67. Jaffe, Bernard. *Men of Science in America.* (The Role of Science in the Growth of our Country.) 600 p. New York: Simon & Schuster. 1944.

68. Johnson, B. L. and others. *What About Survey Courses?* 377 p. New York: Holt. 1937.
Part III. The Survey Course in the Natural Sciences.
Chap. XVI. "Characteristics of Science Survey Courses." Robert J. Havighurst.
Chap. XVII. "Survey Courses in Science as Agencies of General Education." S. Ralph Powers.
Chap. XVIII. "General Education and the Physical Science Survey Course." F. L. Hovde.

69. Jones, A. C. "Nature Study and Elementary Science in the Orient." *School Science and Mathematics,* 33:530–534, May, 1933.

70. Kandel, I. L. *Intellectual Cooperation: National and International.* 78 p. New York: Teachers College, Columbia University. 1944.
Pp. 29–31. "The Place of Science and Technology in Modern Culture."

71. Kartman, Leo. "Soviet Genetics and the Autonomy of Science." *Scientific Monthly,* 61:67–70, July, 1945. (See also No. 97.)

72. Kilander, Holger F. *Science Education in the Secondary Schools of Sweden.* (A Comparative Study of Sweden and the United States.) 166 p. Contribution to Education, No. 463. New York: Teachers College, Columbia University. 1931. Also, *School Science and Mathematics,* 32:522–530, May, 1932.

73. Lenard, Philip. *Great Men of Science.* (A History of Scientific Progress.) 389 p. New York: Macmillan. 1933.

74. Likert, Rensis. "A Technique for the Measurement of Attitudes." 55 p. *Archives of Psychology,* No. 140. New York: Columbia University. 1932.

75. Lovell, Bernard. *Science and Civilization.* 150 p. London: Thos. Nelson. 1939.
esp. Chap. III. "Scientific Method."
Chap. VIII. "The Atmosphere of Science."

76. Madge, Charles and Tom Harrison. *Britain by Mass-Observation.* (A type of public opinion poll.) Harmondsworth: Penguin. 1939.
esp. Pp. 7–22. "The Ordinary Man's Picture of Science."

77. Mather, Kirtley F. *Enough and to Spare.* 186 p. New York: Harper. 1944.
esp. Chap. 4. "The Age of Interdependence."
Chap. 7. "Planning for Freedom."

78. ————, Harry Grundfest, and Melber Phillips. "The Future of American Science." New York: United Office and Professional Workers of America, CIO. 1945. (Also from 3, above.)

79. Meier, Lois. *Natural Science in the German Elementary Schools.* 158 p. Contribution to Education, No. 445. New York: Teachers College, Columbia University. 1930.
Also, *Science Education,* 16:13–17, 94–102, October and December, 1931.

80. Miller, R. Beatrice. "The Method and Content of Science Teaching in France." *Science Education,* 16:355–359, October, 1932.

81. Mitchell, Wesley C. "Science and the State of Mind." (Address to the American Science Teachers Association, Richmond, Virginia, December 29, 1938.) *Science,* 89:2297:4, January 6, 1939.

82. Muelder, Hermann and David M. Delo. *Years of this Land.* 243 p. New York: Appleton-Century. 1943.

83. Mumford, Lewis. *Technics and Civilization.* 495 p. New York: Harcourt, Brace. 1934.

84. National Academy of Sciences. Washington, D. C. Report: "Conference on Problems of Renewing International Scientific and Scholarly Cooperation." December, 1944.
esp. Pp. 49 ff.

85. National Research Council. Washington, D. C.
a. *National Research Fellowships.* 95 p. July 1, 1938. Physical Sciences; Geology and Geography; Medical Sciences; and Biological Sciences.
b. *International Directory of Anthropologists.* 42 p. 1940.
c. *International Scientific Congresses.* (List) 46 p. April, 1941.
d. *Handbook of Scientific and Technical Societies and Institutions in the United States and Canada.* Bulletin No. 106, 4th ed. 1942.
e. "Memo on Future Plans and Activities of International Scientific Organizations, 1919–1944." W. B. Cannon and R. Field. Issued privately by the Division of Foreign Relations. October, 1944.
f. Cannon, Walter B., and R. M. Field. "*International Relations in Science.*" Waltham, Mass.: *Chronica Botanica,* 9:253–298, Autumn, 1945.

86. National Society for the Study of Education. *International Understanding through the Public School Curriculum.* 36th Yearbook, Part II. 363 p. Bloomington, Illinois: Public School Publishing Co. 1937.
esp. Chap. I. "International Understanding and International Interdependence." James T. Shotwell.
Chap. XVIII. "The Natural Sciences: General Considerations." Frederick Barry.
Chap. XIX. "Science in the Elementary School." Gerald S. Craig.
Chap. XX. "Science in the High School." Otis W. Caldwell.

87. Needham, Joseph. *Nazi Attack on International Science.* 48 p. London: Watts. 1941.

88. ———— *Science in Soviet Russia.* 65 p. London: Watts. 1942.

89. ———— *Time: the Refreshing River.* 280 p. New York: Macmillan. 1943.
esp. Pp. 160–177. "The Biological Basis of Sociology."

90. ———— "An International Science Cooperation Service." London: *Nature,* 154:657, 1944.

91. ———— "The Place of Science and International Scientific Cooperation in Post-War World Organization." Memorandum III. Chungking: Author, British Scientific Mission in China. For private circulation. 1945.

92. Oakes, Mervin E. "Science in Soviet Russia." Annotated Bibliography. *The Science Teacher,* XII:28–29, 46, February, 1945.
Also, mimeo., National Council of American-Soviet Friendship, 114 East 32nd St., New York City 16.

93. Okada, Yaichiro. *Science Education in Japan.* 152 p. Seventh World Conference, World Federation of Education Associations. Tokyo: International Printing & Publishing Co. 1937.

94. Orr, J. B. and others. *What Science Stands For.* 132 p. New York: Macmillan. 1938.
esp. Chap. 1. "Nutritional Science and State Planning."
Chap. 4. "Cultural and Social Values of Science."
Chap. 6. "Naturalistic Studies in the Education of the Citizen."

95. Peattie, Donald Culross. *Prairie Grove.* 289 p. New York: Simon & Schuster. 1938.

96. Peattie, Roderick. *Look to the Frontiers.* (A Geography for the Peace Table.) 246 p. New York & London: Harper. 1944.
esp. Chap. XVII. "The Geographic Unity of the World."

97. Polanyi, Michael. "The Autonomy of Science." *Scientific Monthly,* 60:141–150, February, 1945. (See also, No. 71, above.)

98. Ratcliff, J. D. *Yellow Magic.* (The Story of Penicillin.) 173 p. New York: Random House. 1945.

99. *Review of Educational Research.* Washington: American Educational Research Association, National Education Association.
See Index, "International Relations," "Science in other Countries," etc.

100. Rockefeller Foundation, 49 West 49th St., New York City.
a. *Annual Report, 1943.*
Pp. 13–17. "Fundamental Research in Europe."
47–100. "International Health Division."
184. "Data File of Foreign Affairs."
b. *A Review for 1944.* Raymond B. Fosdick, President of Foundation.
Pp. 10–12. "Scientific Research in Europe."
16–20. "Opening Our Own Windows."
21–24. "American Policy and Scientific Research."
24–29. "Salvaging Brains for Postwar Leadership."

101. Rorty, James and N. Philip Norman. "All the Food That's Fit to Eat." *Harper's Magazine,* 191:138–144, August, 1945.

102. Royal Institute of International Affairs. *Survey of International Affairs.* Yearly. London: Oxford University Press.

103. Sarton, George. *The History of Science and the New Humanism.* 196 p. Cambridge: Harvard University Press. 1937.

104. Sax. Karl. "The Demographic Dilemma." *Science,* 101:325–6, March 30, 1945.
(See also, No. 77, above.)

105. Science Service. (The Institution for the Popularization of Science.) 1719 N St., N.W., Washington 6, D. C. Watson Davis, Secretary and Editor, *Science News Letter.* The Weekly Summary of Current Science.

106. Scott, Jonathan F., *The Menace of Nationalism in Education.* 223 p. London: G. Allen & Unwin. 1926.

107. Sears, Paul B. *This Is Our World.* 292 p. Norman, Oklahoma: University of Oklahoma Press. 1937.
esp. Chap. XV. "Society, the Communities of Man.'"

108. ———— *Life and Environment.* (The Interrelations of Living Things.) 175 p. New York: Teachers College, Columbia University. 1939.
esp. Chap. IV. "Human Society as Environment."

109. ———— *Who Are These Americans?* 116 p. New York: Macmillan. 1939.
esp. Chap. IX. "The Changing World of Changing People."
Chap. XIII. "Science Shapes the New World."
Chap. XIV. "Science, Slave or Tyrant?"

110. Singer, Charles. *Story of Living Things.* (A Short Account of the Evolution of the Biological Sciences.) 572 p. New York: Harper. 1931.

111. Smithsonian Institution. *Annual Report, 1942.* Washington, D. C. Pp. 61–69. "International Exchange Service."

112. Stern, Bernhard J. "Restraints upon the Utilization of Inventions." *Annals of the Amer. Acad. of Pol. and Soc. Sci.,* 200:13–31, November, 1938.

113. Sullivan, J. W. N. *The Limitations of Science.* 307 p. New York: Viking Press. 1933.

114. Taylor, F. Sherwood. "Is the Progress of Science Controlled by the Material Wants of Man?" 15 p. Oxford: Society for Freedom in Science, Occasional Pamphlet, No. 1, April, 1945.

115. Trytten, M. H. "The Impending Scarcity of Scientific Personnel." *Scientific Monthly,* 60:37–47, January, 1945.

115-a. Verdoorn, Frans. "The Plant Scientist in the World's Turmoils." Introductory essay, in "Plants and Plant Science in Latin America." Waltham, Mass.: *Chronica Botanica,* June, 1945.

116. Waddington, C. H. *The Scientific Attitude.* 128 p. Harmondsworth and New York: Penguin Books. 1941.

117. *Wartime Technological Developments.* 79th Congress, 1st Session, Senate Subcommittee Monograph No. 2. Washington: U. S. Government Printing Office. May, 1945.

118. Watson, Goodwin B. *Orient and Occident: an Opinion Study.* 120 p. New York: Institute of Pacific Relations. 1927.

119. Wolf, Abraham. *A History of Science, Technology, and Philosophy in the 16th and 17th Centuries.* 692 p. London: Allen & Unwin, and New York: Macmillan. 1935.

120. ———— *History of Science, Technology, and Philosophy in the 18th Century.* 814 p. New York: Macmillan. 1939.

121. Wrightstone, J. Wayne. "Civic Beliefs and Correlated Intellectual and Social Factors." *School Review,* 42:53–58, January, 1934.

122. Ziemer, Gregor. *Education for Death.* (The Making of the Nazi.) 209 p. London: Oxford University Press. 1941.
Pp. 63–81. Visit to a Nature Study class and the Anthropological Museum.
Chap. 9. "Education for Life."

123. Zinsser, Hans. *Rats, Lice, and History.* (The Biography of Typhus.) 301 p. New York: Blue Ribbon Books. 1934.

SCIENCE READING MATERIALS FOR PUPILS AND TEACHERS *

Clarence M. Pruitt
University of Illinois

G. Mathematics

Bakst, Aaron. Mathematics, Its Magic and Mastery. Van Nostrand '41, 790 p. $3.90.

Ball, W. W. Rouse. Mathematical Recreations and Essays. Macmillan '43, 418 p. $2.50.

Bell, Eric T. The Development of Mathematics. McGraw '40, 583 p. $4.50.

Butler, C. H. and Wren, F. L. Teaching of Secondary Mathematics. McGraw '41, 514 p. $3.00.

Hogben, L. T. Mathematics for the Millions. Norton '43, 690 p. $3.75.

Hooper, Alfred. The River of Mathematics. Holt '45, 401 p. $3.75.

Kraitchick, Maurice. Mathematical Recreations. Norton '42, 329 p. $3.75.

McKay, Herbert. Odd Numbers. Macmillan '43. $2.00.

Merriman, Gaylord M. To Discover Mathematics. Wiley '42, 435 p. $3.00.

National Council of Teachers of Mathematics. A Source Book of Mathematical Applications. Bureau '42, 219 p. $2.00.

——— Multi-sensory Aids in the Teaching of Mathematics. '45, 480 p. $2.00.

——— The Place of Mathematics in Secondary Education. '40, 253 p. $1.25.

Northrop, Eugene P. Riddles in Mathematics. Van Nostrand '44, 262 p. $3.00.

Progressive Education Association. Mathematics in General Education. Appleton '40, 423 p. $2.75.

Zant, James H. and Diamond, A. H. Elementary Mathematics from the Historical and Logical Point of View. Burgess '41, 127 p. $1.50.

H. Photography

Adams, Ansel E. Making a Photograph. Studio '40, 104 p. $3.50.

Anderson, Paul L. The Technique of Pictorial Photography. Lippincott '39, 403 p. $3.75.

Arnold, Russ. Flash Photography. Ziff '40, 94 p. $0.95.

Barton, Frederick. Photography as a Hobby. Harper '39, 144 p. $2.00.

Blair, Julian M. Practical and Theoretical Photography. Pitman '45, 243 p. $2.50.

Brown, Robert W. Taking Pictures at Night. Ziff. $0.95.

Boucher, Paul. Fundamentals of Photography. Van Nostrand '40, 304 p. $3.50.

Collins, A. Frederick. The Amateur Photographer's Handbook. Crowell '40, 402 p. $2.50.

DePalma, Victor. Photographic Action. Ziff '40, 110 p. $0.95.

Deschin, Jacob. Finding New Subjects for Your Camera. Whittlesey '39, 239 p. $2.50.

——— Photo Tricks and Effects. Ziff '41, 96 p. $0.95.

Dmitri, Ivan. Color in Photography. Ziff '41. $0.95.

Dunn, Carlton. Natural Color Processes. Photographic '40, 232 p. $2.00.

Edgerton, Harold and Killion, J. R. Flash—Seeing the Unseen by Ultra High Speed Photography. Hale '39, 203 p. $3.00.

Epstean, Edward. Eder's History of Photography. Columbia '45. 860 p. $10.00.

Frapie, Frank R. and Jordan, Franklin, I. American Annual of Photography. '39, '40, '41, '42, '43, '44, '45. $1.50 each.

——— and Morris, Robert H. Copying Technique. Photographic '40, 128 p. $1.50.

——— and Jordan, Franklin. Photographic Hints and Gadgets. Photographic '39, 316 p. $3.50.

——— How to Make Lantern Slides. Ziff '40, 80 p. $0.95.

Gable, J. Harris. Complete Introduction to Photography. Harper '40, 270 p. $3.00.

Gabriel, Hermon. The Camera Gadgeteer. Fomo '40, 63 p. $0.75.

Germain, Morris. Darkroom Handbook and Formulary. Ziff, 118 p. $0.95.

Grierson, Samuel. Outdoor Photography. Ziff '40, 98 p. $0.95.

Hamilton, Edwin T. Trick Photography. Dodd '39, 139 p. $2.50.

Harkness, Norris and Draper, E. E. Table Top Photography. Harcourt '40, 180 p. $2.95.

Henney, Keith. Color Photography for the Amateur. Whittlesey '39, 350 p. $4.75.

——— and Dudley, B. Handbook of Photography. Whittlesey '39, 871 p. $7.50.

Hexter, Paul. Make Your Pictures Sing. Camera '40, 188 p. $3.00.

Jordan, Franklin I. Photographic Enlarging. Photographic '45, 252 p. $3.50.

June, Larry. The Photographic Yearbook. Macmillan '41, 90 p. $1.25.

Kerlee, Charles. Pictures With a Purpose. Camera '39, 80 p. $2.50.

Laurence, A. S. C. The Scientific Photographer. Macmillan '41, 180 p. $3.75.

Lowe, Edmund W. What You Want to Know About Developers. Camera '39, 175 p. $2.50.

Lucas, J. A. and Dudley, B. Making Your Photographs Effective. Whittlesey '40, 385 p. $5.00.

* Concluded from February and March, 1946, Science Education.

MACK, J. E. and MARTIN, M. J. The Photographic Process. McGraw '39, 586 p. $5.00.
MALONEY, T. J. A Pageant of Photography. Crocker '40, 44 p. $0.50.
MARSHALL, L. G. Photo Oil Coloring for Fun or Profit. U. S. Camera '45, 135 p. $2.00.
MEES, C. E. K. Photography. Macmillan '45. 227 p. $3.00.
MILLER, CARL W. Principles of Photographic Reproduction. Macmillan '43, 353 p. $4.50.
MORGAN, WILLARD D. ET AL. 1945 Graphic-Graflex Photography. Simon '45, 450 p. $4.00.
——— 1001 Ways to Improve Your Photographs. Alliance '45, 387 p.
MORTENSEN, WILLIAM. Outdoor Portraiture. Camera '40, 142 p. $2.75.
——— Flash in Modern Photography. Camera '41, 208 p. $4.00.
——— Mortensen on the Negative. Simon '40, 283 p. $4.00.
NEBLETTE, CARROLL. Photography. Van Nostrand '42, 865 p. $7.50.
——— ET AL. Elementary Photography for Club and Home Use. Macmillan '44, 289 p. $1.00.
PECK, A. P. So You Want to Take Better Pictures. Scientific '39, 309 p. $2.00.
PESSELS, KING and GALE, A. L. Making Your Own Movies. Coward '39, 230 p. $3.50.
QUARLES, G. G. Elementary Photography. McGraw '40, 345 p. $3.00.
ROEBUCK, JOHN R. and STAEHLE, H. Photography, Its Science and Practice. Appleton '42, 283 p. $5.00.
ST. CLAIR, R. W. Photographic Lenses and Shutters. Ziff '40. $0.95.
SMALL, F. G. Miniature Camera Technique. Ziff '40, 118 p. $0.50.
SUSCHITZKY, W. Photographing Animals. Studio '41, 80 p. $3.50.
——— Photographing Children. Studio '40, 80 p. $3.50.
TEALE, EDWIN. Boy's Book of Photography. Dutton '39, 252 p. $2.00.
WALL, EDWARD J. and JORDAN, FRANKLIN. Photographic Facts and Principles. Photographic '40, 384 p. $3.00.
WHITE, STEPHEN. Manual of Enlarging. Ziff '40, 94 p. $0.95.

I. Physics

BRITTON, KATHERINE. What Makes It Tick. Houghton '43, 232 p. $2.50.
COMPTON, KARL T.; TRULLINGER, R. and BUSH, VANNEVAR. Scientists Face the World. Rutgers '42, 80 p. $1.25.
DEES, BOWEN C. Fundamentals of Physics and Their Applications in Modern Life. Garden '44, 468 p. $0.69.
DE FOREST, LEE. Television Today and Tomorrow. Dial '42, 361 p. $3.75.
DUNLAP, ORRIN E., JR. Radio's 100 Men of Science. Harper '44, 294 p. $3.50.
EDDY, W. C. Television: The Eyes of Tomorrow. Prentice '45, 330 p. $3.75.
EINSTEIN, ALBERT. The Meaning of Relativity. Princeton '45, 135 p. $2.00.
EVE, A. S. and CREASEY, C. H. Life and Work of John Tyndall. Macmillan '45, 404 p. $6.50.
GRIMES, DAVID. Meet the Electron. Pitman '44, 120 p. $2.00.
HAWLEY, GESSNER G. Seeing the Invisible, the Story of the Electron Microscope. Knopf '45, 200 p. $2.50.
HUBBEL, RICHARD. 4000 Years of Television. Putnam '42, 256 p. $2.25.
HUDSON, RALPH G. An Introduction to Electronics. Macmillan '45, 97 p. $3.00.
JEANS, SIR JAMES. Physics and Philosophy. Macmillan '42, 222 p. $2.75.
LUCKIESH, MATTHEW. Light, Vision and Seeing. Van Nostrand '44, 323 p. $4.50.
——— Torch of Civilization. Putnam '40, 269 p. $3.00.
LUHR, OVERTON. Physics Tells Why. Cattell '43, 318 p. $3.50.
LUNT, JOSEPH R. and WYMAN, W. T. Electricity for Everyone. Macmillan '43, 649 p. $3.25.
MCEACHRON, K. B. and PATRICK, K. G. Playing with Lightning. Random '40, 231 p. $2.50.
MANCHESTER, HARLAND. New World of Machines. Random '45, 313 p. $3.00.
MILLER, DAYTON C. Sparks, Lightning and Cosmic Rays. Macmillan '39, 192 p. $2.50.
MILLIKAN, ROBERT. Cosmic Rays. Macmillan '40, 134 p. $2.50.
MILLS, JOHN. Electronics, Today and Tomorrow. Van Nostrand '44, 178 p. $2.25.
NEIL, HUMPHREY B. 48 Million Horses. Lippincott '40, 241 p. $2.50.
SMYTH, HENRY D. Atomic Energy for Military Purposes. Princeton '45.
TYLER, KINGDOM. Modern Radio. Harcourt '44, 238 p. $3.00.
YATES, RAYMOND F. Machines Over Men. Stokes '39, 249 p. $2.50.
——— Super Electricity: What You Can Do in Electronics. Appleton '42, 165 p. $2.00.

PART VI

TEACHER REFERENCES

A. Keys, Guides and References

ANONYMOUS. Free and Inexpensive Educational Material. Quarrie '40. $5.00.
——— Meteorology and Navigation (14 units). Technical.
——— 1000 and One Blue Books of Non-Theatrical Films. Screen '42–'44. $1.00 each.
——— Visual Aids in Chemistry. New Jersey '40. $0.25.
——— Visual Aids in Geography. New Jersey '40. $0.50.
ARTHUR, PAUL. Lecture Demonstrations in Chemistry. McGraw '39, 455 p. $4.00.
AUDUBON, JOHN J. The Birds of America. Macmillan '41, 435 p. $4.95.
BATES, RALPH S. Scientific Societies in the United States. Wiley '45, 246 p. $3.50.

Bailey, L. H. Gardner's Handbook. Macmillan '41, 292 p. $1.59.

Bennett, Harry. Chemical Formulary. Vols. 4, 5, 6, 7. Chemical '41, '42, '43, '45. $6.00 each.

Clute, William N. Common Names of Plants and Their Meanings. Clute '42, 164 p. $3.00.

Collingwood, G. H. Knowing Your Trees. Forestry '41, 224 p. $2.50.

Comstock, Anna B. Handbook of Nature Study. Comstock '41, 937 p. $4.00.

Cuthbert, Mabel J. How to Know the Spring Flowers. Jaques '43, 168 p. $1.50.

Ditmars, Raymond. Field Book of North American Snakes. Doubleday '39, 305 p. $3.50.

——— Reptiles of the World. Macmillan, 312 p. $1.98.

——— Snakes of the World. Macmillan, 206 p. $1.98.

Driver, Ernest C. Name That Animal Driver '42, 527 p. $5.00.

Duncan, Carl D. and Pickwell, Gayle. The World of Insects. McGraw '39, 409 p. $3.50.

Eddy, Walter G. What Are the Vitamins? Reinhold '41, 247 p. $2.50.

Edey, Maitland. American Song Birds. Random '40, 72 p. $1.00.

Emerson, Arthur I. and Wood, Clarence M. Our Trees and How to Know Them. Lippincott '45. $3.00.

Everett, T. H. A Guide to Wild Flowers. Whitman '45, 64 p. $0.10.

Federal Writers Project. American Wild Life. Wise '40. $3.50.

Fenton, C. L. and Fenton, M. A. The Rock Book. Doubleday '40, 357 p. $6.00.

Fischer, Helen. The Flower Family Album. Minnesota '41, 130 p. $2.50.

Fitzpatrick, Frederick L. The Control of Organisms. Bureau '40, 334 p. $2.75.

Flynn, H. E. and Perkins, F. E. Conservation of the Nation's Resources. Macmillan '41, 385 p. $1.60.

Foley, D. T. and Meikle, C. E. Vegetable Gardening in Color. Macmillan '43, 255 p. $2.50.

Frank, J. O. Mystery Experiments and Problems for Science Classes and Science Clubs. Frank '41, 193 p. $2.25.

Freeman, Mae and Freeman, Ira. Fun With Science. Random '43, 60 p. $1.00.

——— Fun With Chemistry. Random '44, 58 p. $1.25.

Furnas, C. C. The Storehouse of Civilization. Bureau '39, 562 p. $3.25.

Gabrielson, Ira N. Wildlife Conservation. Macmillan '41, 250 p. $3.75.

Glass, H. B. Genes and the Man. Bureau '43, 386 p. $3.50.

Good, Carter V. Dictionary of Education. McGraw '45, 496 p. $4.00.

Grant, Hugh D. Cloud and Weather Atlas. Coward '44, 294 p. $7.50.

Grosvenor, Gilbert and Wetmore, Alexander (Ed.). Book of Birds, Vol. I, Vol. II. National '39, 358 p., 382 p. $5.00 each.

Gustafson, A. F. Soils and Soil Management. McGraw '41, 424 p. $3.00.

Hartnack, Hugo. 202 Common Household Pests of North America. Hartnack '39, 320 p. $5.00.

——— Unbidden Household Guests. Hartnack '44, 560 p. $12.00.

Hausman, L. A. The Illustrated Encyclopaedia of American Birds. Halcyon '44, 541 p. $1.98.

Hazeltine, M. E. Anniversaries and Holidays. Library '45, 316 p. $5.00.

Hegner, Robert and Hegner, Jane. Parade of the Animal Kingdom. Macmillan '42, 675 p. $3.95.

Heilner, V. C. Our American Game Birds. Doubleday '41, 178 p. $5.00.

Heimers, L. Flying and Weather. New Jersey '42, 23 p. $0.50.

——— Health Education. New Jersey '44, 36 p. $0.75.

Henley, G. D. Henley's Twentieth Century Book of Formulas, Processes and Trade Secrets. Henley '45, 885 p. $4.00.

Hickey, Joseph. Guide to Bird Watching. Oxford '43, 262 p. $3.50.

House, Homer D. Wild Flowers. Macmillan, 362 p. $4.95.

Hugard, Jean. Modern Magic Manual. Harper '39, 345 p. $3.50.

Hurley, Richard. Key to Out of Doors. Wilson '39, 256 p. $2.50.

Hylander, Clarence J. World of Plant Life. Macmillan '39, 722 p. $7.50.

Jaques, H. E. How to Know Trees. Jaques '41, 180 p. $1.00.

——— How to Know the Insects. '41, 140 p. $1.80.

——— Plant Families, How to Know Them. '41, 174 p. $1.50.

——— Living Things, How to Know Them. '40, 169 p. $1.00.

——— Plants We Eat and Wear. '43, 171 p. $1.50.

Jenkins, Dorothy. Annual Flowers from Seed Packet to Bouquet. Barrows '45, 223 p. $2.75.

LaGorce, John (Ed.) Book of Fishes. National '39, 357 p. $3.50.

Lamb, Frank. Book of Broadleaf Trees. Norton '39, 367 p. $3.75.

Limback, Russell. American Trees. Random '42, 39 p. $1.00.

Lord, Eugene H. Experimenting at Home with the Wonders of Science. Appleton '40, 243 p. $2.00.

Lutz, Frank. A Lot of Insects. Putnam '41, 304 p. $3.00.

Lynde, C. J. Science Experiments with Home Equipment. Textbook '40, 240 p. $1.39.

——— Science Experiences with Inexpensive Equipment. '40, 272 p. $1.60.

——— Science Experiences with Ten Cent Store Equipment. '41, 256 p. $1.60.

MACY, RALPH W. and SHEPHERD, H. H. Butterflies. Minnesota '41, 247 p. $3.50.
MCFARLAND, JOHN H. Modern Roses II. Macmillan '40, 254 p. $5.00.
———, HATTON, M. and FOLEY, D. J. Garden Bulbs in Color. Macmillan, 296 p. $1.98.
MCKENNEY, MARGARET. A Book of Garden Flowers. Macmillan '41, 80 p. $2.00.
——— Book of Wild Flowers. Macmillan '39, 80 p. $2.00.
——— Wayside Fruits. Macmillan '45, 78 p. $2.00.
——— Trees of the Countryside. Knopf '42, 63 p. $2.00.
——— Birds in the Garden and How to Attract Them. Reynal '39, 349 p. $5.00.
MARSHALL, ROY K. Teachers' Manual of Elementary Astronomy. Franklin '44, 54 p. $0.25.
MATASCHAT, C. H. American Wild Flowers. Random '40. $0.50.
MESEREAU, SAMUEL. Materials of Industry. McGraw '41, 578 p. $2.00.
MORGAN, ANN H. Field Book of Animal Life in Winter. Putnam '39, 527 p. $3.50.
MORGAN, WILLARD D. The Complete Photographer. Alliance '45, 360 p. $37.50.
NEEDHAM, JAMES G. Introducing Insects: A Book for Beginners. Cattell '40, 129 p. $1.75.
NOVAK, EMIL. The Woman Asks the Doctor. Williams '45, 130 p. $1.50.
PALMER, E. LAURENCE. Aids to Knowing Natural Science, Vol. I, The Birds. Slingerland '44, 258 p. $1.50.
PETERSON, ROGER. A Field Guide to the Birds. Houghton '39, 180 p. $1.75.
——— Junior Book of Birds. Houghton '39, 92 p. $2.00.
PICKWELL, GAYLE. Animals in Action. Whittlesey '40, 190 p. $4.00.
——— Deserts. Whittlesey '39, 174 p. $3.50.
——— Weather. 170 p. $3.00.
POPE, CLIFFORD H. Amphibians and Reptiles of the Chicago Area. Museum '45. $1.75.
POST, KENNETH. Plants and Flowers in the Home. Orange '44, 198 p. $2.00.
Prepared with the Cooperation of the Civil Aeronautics Administration and the American Council on Education. Demonstration and Laboratory Experiences in the Science of Aeranautics. McGraw '45, 155 p. $2.00.
QUINN, VERNON. Shrubs in the Garden and Their Legends. Stokes '40, 308 p. $2.50.
——— Stories and Legends of Garden Flowers. Stokes '39, 245 p. $2.50.
——— Vegetables in the Garden and Their Legends. Lippincott '42, 261 p. $2.50.
SCHMIDT, KARL P. and DAVIS, D. D. Field Book of Snakes of the United States. Putnam '41, 365 p. $3.50.
SEARS, PAUL B. Life and Environment Bureau '39, 175 p. $1.85.
SHANKLAND, F. N. Birds. Saalfield '39, 44 p. $0.10.
SHAW, MARGARET and FISHER, JAMES. Animals as Friends and How to Keep Them. Dutton '40, 271 p. $2.50.
SPRAGUE, NORMAN G. Basic Laboratory Practice. Chemical '41, 124 p. $3.50.
STEVENS, G. A. Garden Flowers in Color. Macmillan, 310 p. $1.98.
STEVENSON, ELMO. Nature Games Book. Greenberg '41, 208 p. $2.50.
SYMPOSIUM. Science Hobbies: A Teachers' Guide for Junior High Schools. Publication No. 328. Los Angeles.
——— Climate and Man. Superintendent '41, 1248 p.
VINAL, W. G. Nature Recreation. McGraw '40, 318 p. $3.00.
WEINGART, G. W. Pyrotechnics, Civil and Military. Chemical '43, 220 p. $5.00.
WETMORE, ALEXANDER. Pt. 1, Birds; MILLER, G. S. and GIDLEY, J. Pt. 2, Mammals. Vol. 9, Series '44, 398 p. $5.80.
WILDER, LOUISE BEEBE. The Garden in Color. Macmillan '39, 527 p. $2.95.
WOODS, ROBERT S. The Naturalists' Lexicon. Abbey '45, 282 p. $2.75.
WRIGHT, ANNA E. and WRIGHT, ALBERT. Handbook of Frogs and Toads. Comstock '42, 286 p. $3.00.
YATES, RAYMOND. Science with Simple Things. Appleton '40, 245 p. $2.50.
ZIM, HERBERT S. and COOPER, E. K. Minerals: Their Identification, Uses and How to Collect Them. Harcourt '43, 368 p. $3.00.

B. Professional

AMERICAN COUNCIL OF SCIENCE TEACHERS. Pre-Induction Training. Council '43, 32 p. $1.00.
ANONYMOUS. Science: Audio-visual and Teaching Aids. New Jersey '43, 43 p. $0.75.
——— Science Teaching for Better Living. Redirecting Science Teaching in the Light of Personal-Social Needs and The Education of the Science Teacher. N. E. A., 44 p., 32 p., 80 p. $0.35 each.
——— Influence of the War on Science Teaching. N. E. A. '44, 48 p. $0.35.
——— Reprint of Star Pronunciations. Buffalo. Free.
——— Practical Problems in Physical Science. County '40.
AREY, CHARLES K. Elementary School Science for the Air Age. Macmillan '43, 108 p. $0.72.
——— Science Experiences for Elementary Schools. Bureau '42, 98 p. $1.35.
ARMSTRONG, EARL W.; HOLLIS, ERNEST and DAVIS, HELEN. The College and Teacher Education. Council '44, 311 p. $2.50.
ATYEO, HENRY C. Excursions as a Teaching Technique. Bureau '39, 225 p. $2.35.
Aviation Education Research Group, Teachers College, University of Nebraska. Teachers Manual for Elements of Pre-Flight Aeronautics for High Schools. Macmillan '43, 113 p. $0.48.

BAKER, EMILY. Children's Questions and Their Implications for Planning the Curriculum. Bureau '45, 172 p. $2.35.
BAUER, W. W. Americans Live Longer. Bobbs '40, 219 p. $2.00.
BERGEN, CATHERINE. Some Sources of Children's Information. Bureau '43, 73 p. $1.75.
BINGHAM, N. ELDRED. Teaching Nutrition in Biology Courses. Bureau '39, 117 p. $1.85.
BLACKWELL, GORDON W. Toward Community Understanding. Council '43, 98 p. $0.75.
BLECK, DAVID J. Digest of Investigations in the Teaching of Science. Connecticut '43, 108 p.
BOND, AUSTIN. Experiment in the Teaching of Genetics. Bureau '40, 99 p. $1.85.
BREWER, WILLIAM L. Factors Affecting Student Achievements and Change in a Physical Science Survey Course. Bureau '43, 78 p. $1.60.
BROWN, H. EMMETT. The Development of a Course in Physical Sciences for the Lincoln School. Bureau '39, 205 p. $2.25.
BRUCE, GUY V. Children at Play—Book III and Book IV—Elementary Science Experiments. Bruce.
BRUECKNER, LEO J. The Changing Elementary School. Inor '39, 338 p. $3.50.
BUCK. General Education in a Free Society. Harvard '45. $2.00.
BUREAU OF EDUCATIONAL RESEARCH. Report of the Workshop for Science Teachers Summer 1943. Bureau '43, 65 p. $0.35.
BUSH, GEORGE L. Science Education in Consumer Buying. Bureau '41, 228 p. $2.35.
CLEMENT, JOHN A. Manual for Analyzing and Selecting Textbooks. Garrard '42, 119 p. $2.00.
COMPTON, ARTHUR H. Human Meaning of Science. North Carolina '40, 88 p. $1.00.
COOPER, RUSSELL M. Better Colleges, Better Teachers. Macmillan '44, 167 p. $1.25.
CRAIG, GERALD S. Science in Childhood Education. Bureau '44, 86 p. $0.60.
——— Science for the Elementary School Teacher. Ginn '40, 551 p. $3.00.
CUNNINGHAM, HARRY A. Material Facilities Needed in the Training of Intermediate Grade Teachers in Science. Bureau '40, 162 p. $2.00.
CURTIS, FRANCIS D. Third Digest of Investigations in the Teaching of Science. Blakiston '39, 419 p. $3.50.
DE LIMA, AGNES ET AL. Democracy's High School, the Story of Living and Learning in the Lincoln High School of Teachers College. Bureau '41, 90 p. $0.90.
ECKERT, RUTH. Outcomes of General Education. Minnesota '43, 210 p. $2.00.
ELSBREE, WILLARD. American Teacher. American '39, 566 p. $2.75.
ENGLEHARDT, N. L., JR. Education for the Air Age. Macmillan '43, 53 p. $0.24.
ENGLE, T. L. Psychology. World '45, 549 p. $2.12.
EVEROTE, W. P. Agricultural Science to Serve Youth. Bureau '43, 79 p. $1.85.
FINE, BENJAMIN. Democratic Education. Crowell '45, 251 p. $2.50.
FITZPATRICK, FREDERICK L. and STILES, KARL A. Teachers' Manual for Biology of Flight. Macmillan '43, 27 p. $0.20.
GLASER, EDWARD M. An Experiment with the Development of Critical Thinking. Bureau '41, 212 p. $2.35.
GOOD, CARTER V. Dictionary of Education. McGraw '45, 495 p. $4.00.
HALE, FLORENCE. Science Units and Unit Material for Intermediate and Grammar Grades. Educational '42, 80 p. $0.75.
HARRISON, CHARLOTTE G. Science Experiences for Little Children. Scribners '39, 111 p. $1.50.
HEISS, ELWOOD D.; OBOURN, ELLSWORTH S. and HOFFMAN, C. WESLEY. Modern Methods and Material for Teaching Science. Macmillan '40, 351 p. $2.50.
HOLLIS, ERNEST V. Toward Improving Ph.D. Programs. Council '45, 204 p. $2.50.
HOWARD, FREDERICK T. Complexity of Mental Processes in Science Testing. Bureau '43, 54 p. $1.75.
JEPSON, MAUDE. Biological Drawings with Notes. Chemical '39, 120 p. $2.00.
JONES, F. N. and ARRINGTON, M. G. Explanations of Physical Phenomena Given by White and Negro Children. Comparative Psychology Monograph, Vol. 18, No. 5. Williams '45, 43 p. $1.00.
KENNEDY, MILLARD and HARLOW, A. F. Schoolmaster of Yesterday. Whittlesey '40, 359 p. $2.75.
KILGORE, W. A. Identification of Ability to Apply Principles of Physics. Bureau '41, 34 p. $1.60.
KILPATRICK, WILLIAM H. Selfhood and Civilization. Macmillan '41, 343 p. $1.50.
LAIRD, DONALD A. The Technique of Handling People. Whittlesey '43, 139 p. $1.75.
——— Technique of Building Personal Leadership. Whittlesey '44, 239 p. $2.00.
LATON, ANITA D.; BAILEY, EDNA W. and SCHWAB, JOSEPH. Suggestions for Teaching Selected Material from the Field of Genetics. Bureau '39, 66 p. $0.50.
LUTES, DELLA T. Country Schoolma'am. Little '41, 328 p. $2.00.
MANZER, J. G.; PEAKE, M. M. and LEPA, J. M. Physical Science in the Air Age. Macmillan '43, 182 p. $0.80.
MARTIN, LYCIA. The Prediction of Success for Students in Teacher Education. Bureau '44, 110 p. $2.00.
MAYFIELD, JOHN C.; PARKER, BERTHA M. and BLOUGH, GLENN O. Science Instruction in Elementary and High School Grades. Chicago '39, 232 p. $1.75.
MEDER, ELSIE MARIE. Youth Considers the Heavens. King '42, 60 p. $1.00.
MENDENHALL, J. E. and HARAP, HENRY. Consumer Education. Appleton '43, 399 p. $2.50.
NEW YORK ASSOCIATION OF BIOLOGY TEACHERS. Adventures in Biology. Steiner '40. $0.50.
NOLL, VICTOR H. The Teaching of Science

in Elementary and Secondary Schools. Longmans '39, 238 p. $2.00.

OLSEN, EDWARD G. School and Community. Prentice '45, 422 p. $3.75.

OLSON, O. S. Methods of Teaching High School Biology. Burgess '40, 48 p. $1.25.

PACE, C. ROBERT. They Went to College. Minnesota '41, 148 p. $2.50.

PALMER, E. LAURENCE. Cornell Nature Study Philosophy. Palmer '44, 80 p. $0.20.

PECK, JOHN S. Science and New York City. Bureau '40, 76 p. $1.25.

PITLUGA, G. E. Science Excursions into the Community. Bureau '43, 154 p. $1.75.

POWERS, SAMUEL RALPH and GRANT, CHARLOTTE. Forests and Man. Bureau '42, 37 p. $0.20.

——— ET AL. You and the Wealth of the Earth. Bureau '41, 51 p. $0.25.

PRALL, CHARLES E. and CUSHMAN, C. L. Teacher Education in Service. Council '44, 503 p. $3.00.

RANSOM, SARAH. Consumer Chemistry. New Jersey '45, 36 p. $0.75.

REMMERS, H. H. and GAGE, N. L. Educational Measurement and Evaluation. Harper '43, 580 p. $3.25.

RENNER, GEORGE T. Geographic Education for the Air Age. Macmillan '43, 15 p. $0.20.

RIDDLE, OSCAR. The Teaching of Biology in the Secondary Schools of the United States. Miller '41, 76 p. Free.

RYDER, RAYMOND. Effect of Student Teaching on Secondary Pupils in Achievement and Attitude. Purdue '44, 155 p. $1.50.

SANDERSON, CLARA. Adventure of Pedagogy. Caxton '42, 441 p. $4.00.

SCHOOL OF EDUCATION FACULTY OF STANFORD UNIVERSITY. Education in Wartime and After. Appleton '43, 465 p. $3.00.

SECONDARY SCHOOL PRINCIPALS OF N. E. A. The Place of Science in the Education of the Consumer. N. E. A. '45, 32 p. Free.

SHOEMAKER, LOIS M. and MORRIS B. Science in the Lanning Demonstration School of the State Teachers' College, Trenton, New Jersey. Bookstore '44, 130 p. $1.00.

SPAFFORD, IVOL ET AL. Building a Curriculum for General Education. Minnesota '43, 353 p. $3.00.

STEVENS, BERTHA. How Miracles Abound. Day '41, 200 p. $2.50.

——— and STECKMESSER, GEORGE. Teaching Science in the Elementary School. Progressive '42, 31 p. $0.25.

STODDARD, GEORGE D. The Meaning of Intelligence. Macmillan '43, 504 p. $4.00.

STOVER, GEORGE F. Teachers' Manual for Science of Pre-Flight Aeronautics for High School. Macmillan '43, 248 p. $0.80.

STOLLBERG, ROBERT J. Suggestions for Teaching Selected Material from the Field of Electricity. Bureau '41, 142 p. $0.75.

SYMPOSIUM. Illustrated Elementary Science Units: Airplanes; Animals; Astronomy; Birds; Clothing; Communication; Farm Life; Fishing; Food; Natural Resources; Plant Life; Sea Creatures; Shelter; Transportation; Trees; Weather; Wild Flowers; and Rocks and Minerals. Owen. $0.30 each.

SYMPOSIUM. Elementary Science Poems Teachers Ask For—Books I and II. Owen. $0.25 each.

SYMPOSIUM. Newer Instructional Practices of Promise. Supervision '40. $2.00.

SYMPOSIUM. Proceedings of the Workshop in General Education 1940. Vol. VI. Science. Council '40.

SYMPOSIUM. Teachers for Our Times. Council '44. $2.00.

SYMPOSIUM. Thirty Schools Tell Their Story. Harper '43, 802 p. $4.00.

THAYER, VIVIAN T. American Education Under Fire. Harper '44, 193 p. $2.50.

——— Reorganizing Secondary Education. Appleton '39, 483 p. $2.75.

THORNDIKE, EDWARD L. Human Nature and Social Order. Macmillan '40, 1019 p. $4.00.

TOWNES, MARY. Teaching With Motion Pictures: A Guide to Sources of Information and Materials. Bureau '40, 29 p. $0.35.

TROYER, M. E. and PACE, C. ROBERT. Evaluation in Teacher Education. Council '44, 368 p. $3.00.

UNDERHILL, ORRA ERWIN. The Origins and Development of Elementary School Science. Scott '41, 347 p. $2.50.

URBAN, JOHN. Behavior Changes Resulting from a Study of Communicable Diseases. Bureau '43, 110 p. $1.85.

VAN NESS. CHARLES R. Tact and the Teacher. School. $0.50.

WATERS, E. A. A Study of the Application of an Educational Theory to Science Education. Bureau '41, 134 p. $1.60.

WELLS, HARRINGTON. Teaching of Nature Study and the Biological Sciences. Christopher '40, 342 p. $4.00.

WILLIAMS, ALICE M. Children's Choices in Science Books. Bureau '39, 163 p. $1.85.

WESMAN, ALEXANDER G. Study of Transfer of Training from High School to Intelligence. Bureau '45, 82 p. $1.75.

WOODRING, MAXIE N.; OAKES, M. E. and BROWN, H. E. Enriched Teaching of Sciences in the High School. Bureau '41, 402 p. $3.25.

WRIGHTSTONE, J. WAYNE, and MEISTER, MORRIS (Editors). Looking Ahead in Education. Ginn '45, 151 p. $1.50.

ZELLER, DALE. The Relative Importance of Factors of Interest in Reading Materials for Junior High School Pupils. Bureau '41, 89 p. $1.60.

ZIM, HERBERT S. Science Interests and Activities of Adolescents. Zim '40, 256 p. $2.50.

——— This Is Science. Association '45, 44 p. $0.50.

PUBLISHERS

Abbey. Abbey Garden Press, Pasadena, California.

Abingdon. Abingdon-Cokesbury Press. Nashville 2, Tennessee.
Ackerman. Bernard Ackerman, Inc., 116 E. 19th St., New York 3.
Alliance. National Educational Alliance, 37 W. 47th St., New York 19.
Allyn. Allyn and Bacon, 50 Beacon St., Boston 8.
American. American Book Company, 88 Lexington Ave., New York 16.
Appleton. D. Appleton-Century Company, 35 W. 32nd St., New York 1.
Association. Association for Childhood Education, 1201 Sixteenth St., N.W., Washington 6.
Banta. R. E. Banta, Crawfordsville, Indiana.
Barnes. A. S. Barnes, 67 W 44th St., New York 18.
Barrows. M. Barrows and Company, 443 Fourth Ave., New York.
Blakiston. The Blakiston Company, 1012 Walnut St., Philadelphia 5.
Bobbs. Bobbs-Merrill Company, 724 N. Meridian, Indianapolis 7.
Bookstore. College Bookstore, State Teachers College, Trenton, New Jersey.
Brookings. Brookings Institution, 722 Jackson Pl., N.W., Washington.
Bruce. Prof Guy Bruce, Newark State Teachers College, Newark.
Buffalo. Buffalo Museum of Science, Humboldt Park, Buffalo.
Bureau. Bureau of Publications, Teachers College, Columbia University, New York.
Burgess. Burgess Publishing Company, 426 S. Sixth St., Minneapolis, Minnesota.
Cadmus. Cadmus Publishing Company, Inc., 15 W. 48th St., New York.
California. University of California Press, Berkeley, California.
Camera. Camera Craft Publishing Company, 425 Bush St., San Francisco 8.
Cardy. Beckley-Cardy Company, 1632 Indiana Ave., Chicago.
Cattell. Jaques Cattell Press, Lancaster, Pennsylvania.
Caxton. Caxton Printers, Ltd., Caldwell, Idaho.
Chapman. Chapman and Grimes, 30 Winchester St., Boston.
Chemical. The Chemical Publishing Company, 26 Court St., Brooklyn 2.
Chicago. University of Chicago Press, 5750 Ellis Ave., Chicago.
Christopher. Christopher Publishing House, 1140 Columbus Ave., Boston.
Clute. Willard N. Clute, 5057 Hinesley Ave., Indianapolis.
College. College Entrance, Book Company, 104 Fifth Ave., New York 11.
Colonial. Colonial Book Company, Inc., 104 Fifth Ave., New York.
Columbia. Columbia University Press, 2960 Broadway, New York 27.
Commonwealth. Commonwealth Fund, 41 E. 57th St., New York.
Comstock. Comstock Publishing Company, 124 Roberts Pl., Ithaca, New York.
Connecticut. University of Connecticut, Storrs, Connecticut.
Cornell. Cornell University Press, 124 Roberts Pl., Ithaca, New York.
Cornell Maritime. Cornell Maritime Press, 350 W. 23rd St., New York.
County. Office of County Superintendent of Schools, Division of Secondary Education, Los Angeles.
Council. American Council on Education, 744 Jackson Pl., N.W., Washington 6.
Coward. Coward-McCann, Inc., 2 W. 45th St., New York 19.
Creative. Creative Age Press, 11 E. 44th St., New York 17.
Crocker. H. S. Crocker Company, 735 Harrison St., San Francisco.
Crowell. Thomas Y. Crowell Publishing Company, 432 Fourth Ave., New York 16.
Day. John Day Company, Inc., 2 W. 45th St., New York 19.
Dial. Dial Press, Inc., 432 Fourth Ave., New York.
Didier. Didier Publishers, 600 Madison Ave., New York 21.
Dodd. Dodd, Mead and Company, 432 Fourth Ave., New York.
Doubleday. Doubleday and Company, Garden City, New York.
Dryden. The Dryden Press, 386 Fourth Ave., New York 16.
Driver. Ernest C. Driver, 119 Prospect St., Northampton, Massachusetts.
Duell. Duell, Sloan and Pearce, Inc., 270 Madison Ave., New York.
Dutton. E. P. Dutton and Company, 286 Fourth Ave., New York 10.
Educational. Educational Publishing Company, Darien, Connecticut.
Eerdsman. William B. Eerdsman Publishing Company, 234 Pearl St., N.W., Grand Rapids, Michigan.
Emerson. Emerson Books, Inc., 251 W. 19th St., New York.
Farrar. Rinehart and Company, 232 Madison Ave., New York 16.
Follett. Follett Publishing Company, 1255 S. Wabash Ave., Chicago 5.
Fomo. Fomo Publishing Company, Canton, Ohio.
Foremost. Foremost Books, 353 Fourth Ave., New York 10.
Forestry. American Forestry Association, 919 17th St., N.W., Washington.
Foster. Foster and Stewart, Publishing Company, 210 Ellicott St., Buffalo 3.
Frank. J. O. Frank, Oshkosh, Wisconsin.
Franklin. The Franklin Institute, Philadelphia.
Funk. Funk and Wagnalls Company, 354 Fourth Ave., New York.
Garden. Garden City Publishing Company, Garden City, New York.

Garrard. Garrard Press, 119 W. Park Ave., Champaign, Illlnois.

Geographical. American Geographical Society, Broadway and 156th St., New York 32.

Ginn. Ginn and Company, Statler Bldg., Boston 17.

Goodyear. Goodyear Tire and Rubber Company, Akron.

Gregg. The Gregg Publishing Company, 6 N. Michigan Ave., Chicago 2.

Greenberg. Greenberg Publisher, Inc., 400 Madison Ave., New York.

Greystone. The Greystone Press, 40 E. 49th St., New York.

Grosset. Grosset and Dunlap, 1107 Broadway, New York 10.

Guernsey. The American Guernsey Cattle Club, Peterborough, New Hampshire.

Halcyon. Halcyon House Publications, Garden City, New York.

Hale. Ralph T. Hale and Company, 3 Joy St., Boston.

Harcourt. Harcourt Brace and Company, 383 Madison Ave., New York 17.

Harper. Harper and Brothers, 383 Madison Ave., New York 17.

Hartnack. Hartnack Publishing Company, 324 N. 4th St., Tacoma, Washington.

Harvard. Harvard University Press, 38 Quincy St., Cambridge 38.

Hastings. Hastings House, 67 W. 44th St., New York 18.

Heath. D. C. Heath and Company, 285 Columbus Ave., Boston 16.

Henley. Norman W. Henley Publishing Company, 17 W. 45th St., New York.

Hinds. Hinds, Hayden and Eldredge, Inc., 105 Fifth Ave., New York.

Holiday. Holiday House, 72 Fifth Ave., New York 11.

Holt. Henry Holt and Company, 257 Fourth Ave., New York.

Hopkins. Johns Hopkins University Press, Baltimore.

Houghton. Houghton, Mifflin Company, 2 Park Ave., Boston 7.

Howell. Howell, Soskin, 17 E. 45th St., New York 17.

Humphries. Bruce Humphries, Inc., 30 Winchester St., Boston 6.

Indiana. Indiana University Book Store, Bloomington, Indiana.

Inor. Inor Publishing Company, 207 Fourth Ave., New York.

International. International Publishers Company, 381 Fourth Ave., New York 16.

Iroquois. Iroquois Publishing Company, Chimes Bldg., Syracuse.

Ives. Ives Washburn, 29 W. 57th St., New York 19.

Jaques. H. E. Jaques, Mt. Pleasant, Iowa.

Journal. Journal of Chemical Education, Easton, Pennsylvania.

Kennedy. P. J. Kennedy and Sons, 12 Barclay St., New York 8.

Kings. Kings Crown Press, 2960 Broadway, New York 27.

Knopf. Alfred A. Knopf, Inc., 501 Madison Ave., New York 22.

Library. American Library Association, 520 N. Michigan Ave., Chicago 11.

Linker. Wilmurt B. Linker, 20 Exchange Pl., New York 5.

Lippincott. J. B. Lippincott Company, 227 S. Sixth St., Philadelphia 5.

Little. Little, Brown and Company, 34 Beacon St., Boston 6.

Longmans. Longmans, Green and Company, Inc., 55 Fifth Ave., New York 3.

Los Angeles. Los Angeles City School District, Board of Education, Los Angeles.

Lothrop. Lothrop, Lee and Shepherd Company, 419 Fourth Ave., New York 6.

Lyons. Lyons and Carnahan, 2500 Prairie Ave., Chicago 16.

McBride. Robert M. McBride and Company, 116 E. 16th St., New York 3.

McGraw. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 18.

McKay. David McKay Company, 604 S. Washington Square, Philadelphia 6.

McKnight. McKnight and McKnight, Bloomington, Illinois.

Macmillan. The Macmillan Company, 60 Fifth Ave., New York 11.

Messner. Julius Messner, Inc., 8 W. 40th St., New York 18.

Mill. M. S. Mill Company, Inc., 286 Fifth Ave., New York.

Miller. Dr. D. F. Miller, Dept. of Zoology, Ohio State University, Columbus.

Minnesota. University of Minnesota Press, Minneapolis.

Morrow. William Morrow and Company, 425 Fourth Ave., New York 16.

Motors. Educational Service, General Motors Corporaiton, Detroit.

Murray. Murray and Gee, Hollywood 28, California.

Museum. Chicago Natural History Museum, Chicago.

National. National Geographic Society, 16th and M Sts., N.W., Washington 6.

N. E. A. National Education Association, 1201 16th St., N.W., Washington 6.

Nelson. Thomas Nelson and Sons, 385 Madison Ave., New York 17.

New Jersey. New Jersey State Teachers College, Montclair, New Jersey.

Noble. Noble and Noble, Publishers, Inc., 72 Fifth Ave., New York 11.

North Carolina. University of North Carolina Press, Chapel Hill, North Carolina.

Norton. W. W. Norton and Company, Inc., 70 Fifth Ave., New York 11.

Northwestern. University of Northwestern Press, Evanston, Illinois.

Odyssey. Odyssey Press, Inc., 386 Fourth Ave., New York 16.

Oklahoma. University of Oklahoma Press, Norman, Oklahoma.

Orange. Orange, Judd Publishing Company, Inc., 15 E. 26th St., New York 10.
Owen. F. A. Owen Publishing Company, Dansville, New York.
Oxford. Oxford University Press, 114 Fifth Ave., New York 11.
Page. L. C. Page and Company, 53 Beacon St., Boston 8.
Palmer. E. Laurence Palmer, Cornell University, Ithaca, New York.
Paradise. Paradise of the Pacific, Limited, P. O. Box 80, Honolulu, T. H.
Pharmacy. Philadelphia College of Pharmacy and Science, Philadelphia.
Photographic. American Photographic Publishing Company, 353 Newberry St., Boston 15.
Pitman. Pitman Publishing Corporation, 2 W. 45th St., New York 19.
Prentice. Prentice-Hall, Inc., 70 Fifth Ave., New York 11.
Princeton. Princeton University Press, Princeton, New Jersey.
Purdue. Purdue University Division of Educational Reference, Lafayette, Indiana.
Progressive. Progressive Education Association, 221 W. 57th St., New York 19.
Putnam. G. P. Putnam's Sons, Inc., 2 W. 45th St., New York 19.
Quarrie. Quarrie Reference Library, 35 E. Wacker Drive, Chicago.
Rand. Rand, McNally and Company, 536 S. Clark St., Chicago 5.
Random. Random House, Inc., 20 E. 57th St., New York 22.
Reilly. Reilly and Lee, 325 W. Huron St., Chicago 10.
Reinhold. Reinhold Publishing Corporation, 330 W. 42nd St., New York 18.
Research. Research Publishing Company, 126 W. 3rd St., Los Angeles.
Revell. Fleming H. Revell Company, 158 Fifth Ave., New York 10.
Reynal. Reynal and Hitchcock, 8 W. 40th St., New York 18.
Row. Row, Peterson and Company, 1911 Ridge Road, Evanston, Illinois.
Roy. Roy Publishers, 25 W. 45th St., New York 19.
Rubber. U. S. Rubber Company, Rockefeller Center, New York.
Rutgers. Rutgers University Press, New Brunswick, New Jersey.
Saalfield. Saalfield Publishing Company, Akron, Ohio.
Sanborn. Benj. H. Sanborn and Company, 221 E. 20th St., Chicago 16.
Saunders. W. B. Saunders and Company, 218 W. Washington Sq., Philadelphia 5.
School. School Activities, Topeka, Kansas.
Science. Science Service, 1719 N St., N.W., Washington.
Scientific. Scientific American Publishing Company, 24 W. 40th St., New York 18.
Scott. Scott, Foresman and Company, 623 S. Wabash Ave., Chicago 5.
Scott, W. R. William R. Scott, Inc., 72 Fifth Ave., New York 11.
Screen. Educational Screen Company, 64 East Lake Drive, Chicago.
Scribners. Charles Scribners Sons, 597 Fifth Ave., New York 17.
Series. Series Publishers, Inc., 11 W. 42nd St., New York 18.
Sheridan. Sheridan House, Inc., 257 Fourth Ave., New York 10.
Silver. Silver Burdett Company, 45 E. 17th St., New York 3.
Simmons. Simmons-Boardman Publishing Company, 30 Church St., New York 7.
Simon. Simon & Schuster, Inc., 1230 Sixth Ave., Rockefeller Center, New York 20.
Singer. L. W. Singer and Company, 249 W. Erie Blvd., Syracuse.
Slingerland. Slingerland Publishing Company, Ithaca, New York.
Stanford. Stanford University Press, Stanford University, California.
Steck. Steck and Company, 9th and Lavaca Sts., Austin, Texas.
Stephens. Stephens College Book Store, Columbia, Missouri.
Stewart. George W. Stewart Publishers, Inc., 67 W. 44th St., New York 18.
Steiner. E. R. Steiner, Grover Cleveland High School, Brooklyn.
Stokes. Frederick Stokes Company, 227 S. Sixth St., Philadelphia 5.
Studio. Studio Publications, 381 Fourth Ave., New York 16.
Superintendent. Superintendent of Documents, Government Printing Office, Washington.
Supervision. Department of Supervision and Directors of Instruction, 1201 16th St., Washington 6.
Technical. American Technical Society, 850 E. 58th St., Chicago 57.
Textbook. International Textbook Company, Scranton, Pennsylvania.
U. S. Camera. U. S. Camera Publishing Corporation, 420 Lexington Ave., New York 20.
Vanguard. Vanguard Press, Inc., 424 Madison Ave., New York 17.
Van Nostrand. D. Van Nostrand Company, Inc., 250 Fourth Ave., New York 3.
Viking. The Viking Press, Inc., 18 E. 48th St., New York 17.
Webb. Webb Book Publishing Company, 55 E. 10th St., St. Paul 2.
Weber. Weber Costello Company, Chicago.
Webster. Webster Publishing Company, 1800 Washington Ave., St. Louis 3.
Westinghouse. Westinghouse Electric and Manufacturing Company, Pittsburgh.
Whitman. Albert Whitman and Company, 56 W. Lake St., Chicago 6.
Whittlesey. Whittlesey House, 330 W. 42nd St., New York 18.
Wilcox. Wilcox and Follett Company, 1255 S. Wabash Ave., Chicago 5.
Wiley. John Wiley and Sons, Inc., 440 Fourth Ave., New York 16.

Williams. The Williams and Wilkins Company, Mt. Royal and Guilford Aves., Baltimore.
Wilson. The H. W. Wilson Company, 950 University Ave., New York 52.
Winston. John C. Winston Company, 1006 Arch St., Philadelphia 7.
Wisconsin. University of Wisconsin Press, Madison 5.
Wise. Wm. H. Wise and Company, 50 W. 47th St., New York 19.
World. World Book Company, Yonkers-on-Hudson 5.
World Pub. World Publishing Company, 14 W. 49th St., Rockefeller Center, New York 20.
Yale. Yale University Press, New Haven, Connecticut.
Ziff. The Ziff-Davis Publishing Company, 540 N. Michigan Ave., Chicago 11.
Zim. Herbert S. Zim, Ethical Culture School, New York.

UNSCIENTIFIC METHOD IN SCIENCE TEACHING

PAUL F. BRANDWEIN
Forest Hills High School, Forest Hills, New York

ONE of the pervasive aims of science teaching, reiterated in every work in science education, constantly emphasized at all teachers' meetings, claimed as the umbilical cord which feeds all the sciences, is the inculcation of the scientific method of thinking. Though scientific method and scientific attitude have been separated, it will be granted that true scientific thinking combines both in an inextricable fashion. This scientific thinking is taken as a characteristic method of thought, at least, of two groups of people—scientists (in their laboratories) and science teachers (in their classrooms), though it is not, of course, confined to these groups. Consider then the paradox of science teachers using unscientific method in the science classroom. It can be expected, humans being what they are, that under the stress of daily living, under the stress of balancing opposing opinion and action, that scientists or science teachers might at times be conceivably unscientific in their reactions to the world outside of the laboratory or the classroom. But in the laboratory or classroom the science teacher is expected to be the teacher scientist and confine himself rigorously to the scientific method.

Every science course has its series of demonstrations and experiments. As a matter of fact it is these activities which are the distinguishing outer physical characteristics of the science course and banish it from the realm of chalk-talk presentation. Visual aids have been a *sine qua non* of the science course for a long time; yes, long before educators *per se* discovered visual aids. And it may be worthwhile to comment here that activity has also been a characteristic of good science teaching; yes, even long before educators *per se* recognized that activity as method was an instrument to spur the growth of children, the interest of adults, and the rehabilitation of war veterans. Science teachers see a confirmation of their long standing practices in the increasing adoption of these tools—visual aids and activity—by other teachers.

But we are concerned here with the precise scientific use of the experiment—or demonstration—as visual aid or activity. Some teachers have hastened to discard the word experiment when they mean demonstration. They recognize that the experiment involves much more. An experiment, many teachers affirm, is generally an activity to *find out* rather than *to prove* while the demonstration concerns itself with the latter rather than the former. This is dealing purely in words. The essential feature of a scientific activity such as a demonstration-experiment is its validity.

The validity of an experiment, granting that it fulfills the purpose for which it is designed, depends on the number of times the results are attained. No scientist would permit himself to base his final conclusions on the results of a single experiment. Yet this is quite a common procedure in a good many classrooms in this country.

A teacher may be interested in showing

a class that plants manufacture starch. One plant is generally used. One leaf is tested. There is generally one control. Perhaps O_2 is being prepared. Several bottles are prepared from one mixture of MnO_2 and $KClO_3$. On the basis of observations in classrooms in several cities on the Eastern seaboard, on teaching procedures dealing with classroom experiments, the conclusion is inescapable that these classes observed came to conclusions on the one experiment performed. This occurred in every class observed. During the past three years more than 200 teachers from states throughout the country, have admitted the same practices as common in their schools. Further, during the past three years the writer has noted the same procedure in graduate and undergraduate college courses. Generally speaking, one experiment serves to demonstrate the principle in question.

But witness the teacher's attitude when a student generalizes on the basis of one, or very few, experiences. This is usually the case when students admit to racial prejudice, or some superstition. The teacher is quite correct in admonishing the student that a conclusion based on one, or even a few experiences, is invalid. The teacher is quite correct in assuring the student that such thinking is unscientific. But the same criticism can be directed at the teacher. During the entire semester or school year, in the majority of cases, classes have been coming to generalization on the basis of one (rarely two) demonstration-experiments.

Now it is clear that no science teacher has the intention of appearing unscientific. He probably feels, and this point of view has been expressed, that he is merely repeating something that has been done so many, many times—and once more is enough. Apart from the possibility that this attitude during the performance of the experiment may not contribute to its enthusiastic reception by the class, it is still true that for the students the experiment performed is probably a first experience. These experiments furnish an unexcelled opportunity for the inculcation of one aspect of scientific method—namely, conclusions are based on many different experiments, repeated many times.

There is no assumption here that the constant practice of allowing the class to conclude on the basis of one experiment, induces more of an unscientific attitude than the students already have. It is held, however, that the very act of performing just one experiment and permitting a class to conclude from it alone is unscientific practice.

In laboratory work, where every student obtains similar results and thus confirms others, this does not occur. But it is possible for the teacher to perform several experiments in certain cases where the equipment and materials lend themselves to facille repetition. Emphasis on the need for repetition by the students will enable the teacher to bring to the class the recognition of the part carefully repeated work plays in science. Where the apparatus and materials are of such a nature as to obviate repetition then the teacher may—after obtaining the results of one experiment—state to the class that this result confirms many, many similar results obtained by scientists and science teachers. The writer has satisfied himself that where this is done in certain classes students have a more concrete appreciation (verbal and written) of the kind of evidence needed to serve a conclusion than do students in other classes who are constantly permitted to conclude from one demonstration experiment.

Whether this be true or not, there is still no reason why teachers of science should engage in practices which are unscientific in nature when the very practices in which they are engaging are supposed to give young people an understanding of the nature of scientific method. And one of the characteristics of one who uses the scientific method is his reliance on evidence obtained from many observations, many experiments—not one observation, nor one experiment.

THE SCIENCE EDUCATION OF THE NON-COLLEGE HIGH SCHOOL STUDENT

John Gammons Read
Rhode Island College of Education, Providence, R. I.

The non-college students of today will constitute a better than 5 to 1 majority over college graduates when they get out into the world. Ten years from now they will determine, through personal opinion and through their votes, what is to be done with the new society which science is now building through its processes, industrial materials, and foodstuffs. It is likely that this society will differ from our present one both economically and socially; in what direction, it is now hard to predict; but it will be based largely on technical production and invention. The men of science in industry, agriculture, and in medicine must have the intelligent and grateful support of a majority of our citizens, college and non-college, and this majority must see to it that industry and government continue to support research in science for the good of all humanity.

We have not forgotten that the liberal arts must survive in a democracy; and that they, too, survive only at the pleasure of the majority. The high school, not the college, is now the incubator of both the liberal arts and the sciences.

It is futile to expect to train this high school pupil vocationally in science or in anything else. Sixty-five per cent of the jobs he or she will get require no training of any consequence; the remaining jobs often require specialized skills that cannot be taught in the school. Nevertheless, some general abilities can be developed in the science courses. These will transfer to other areas, if this transfer is planned.

What are these general abilities, and why are they valuable? One of them is the ability to follow accurately oral or printed directions (and later to give them so that they cannot be misunderstood). The Army has found it necessary to devise a highly formal written communications system; many business firms have done the same. Mistakes in interpretation are too costly to be tolerated. The natural sciences, in the experimental field, offer vigorous, highly-motivated training which finally leads to the acquisition of the ability to follow directions; for Nature has a way of cracking you over the knuckles if you make a mistake. Have you ever taken hold of a live 110-volt wire?

Another ability concerns perseverance; not until 75 per cent, or 90 per cent, is reached, but until the machinery runs smoothly and effectively, as it does its grinding or pulling or flying. This near-perfection comes only when defects are analyzed, one-by-one, and then attacked in the same manner. The good mechanic, the good experimenter, the good electrician, and the *good citizen* attack the problems they face in the same manner.

Finally, the small skills of biology, of chemistry, of photography and radio repair are those that carry over to adult life and are the hobby-skills. Do you raise fantails and swords, do you do color-printing of your best transparencies, do you install an extra loudspeaker in the kitchen?

Finally, science teaching can give to young people some of the adventure and zest of pioneer life. Each new experiment, every day's observation of the living world on the way to school or work, opens pupils' eyes to this complex and wonderful world about them, so that they never need be lonely or bored again.

How can this kind of science be taught? By whom? And in what kind of a school environment?

Survey courses have been suspect because they often attempted to feed the pupil undigestible capsules of special sciences

instead of giving him hearty well-balanced meals of science units, each one of which would make him grow measurably.

Here are *all* the units which are suitable for a course in the high schools of the United States in 1945–46.

1. Life-preservation for personal and group protection against disease, accident, drugs, and premature aging of mind and body.

2. Conservation and agriculture, showing man's place in the living world; his relation to the soil, to food supply, food preservation and preparation; his relation to other living things, including other humans and to the forces of heredity and environment which have moulded him and his world. Psychology and economics are part of this unit. We may also be preparing him for an economy which will get him away from the city for a part of each day and each week; where he will work on a small subsistence farm, making his economic future more secure, and his physical and mental health immeasurably better.

3. Astronomy—man's insignificant size as compared with a huge universe composed of billions of units of stars, comets, planets, nebulae, and galaxies; but stressing the importance of Man the Astronomer, who with his God-given mind is able to see if not to comprehend this vast space in which he dwells. Stressing too, the personal responsibility of every individual for planning the future of the human race.

4. Science principles and concepts are able to explain every common happening in terms of a comparatively few lowest common factors. With these factors well learned, the pupil loses superstition and replaces it with thought. He gains respect for the men who take these factors, the realia and the ideas of science, and build new and better structures for man's use. Electronics, power-use, and aviation are currently the new broad areas from which units may be drawn. Many of the industrial chemical processes are found in this field, often called physical chemistry. Most of the rest of chemistry will have appeared in the units on life-preservation and in conservation and agriculture.

By whom is this science to be taught? By men and women trained in the five years of college so that they are experts in teaching; so that they are well-grounded but are not specialists in all sciences. Further, they should have had real experiences during summer vacations, on the farm, with children in camps and in crowded urban areas, and in industry. Perhaps the college can arrange and supervise these experiences so that they may best teach that broadness of viewpoint all teachers need. We know how to train these teachers, but today they are rare; there are very few *specialists* in the *general science* of mankind.

Where can this science be taught? In every high school where there can be a workshop in science, with books and tools and experiments for the solving of problems which come out of cooperative planning by teachers and pupils. It makes littie difference what these problems are. If they sample every area mentioned they will be adequate. Teaching in the sciences should be carried on for one semester in every high school year. At least one double period a week should be planned, and better, two.

In every high school? This science must reach enough of the 5,000,000 non-college students so that a majority of them, now good-intentioned boys and girls, will also be well-informed. If we do not so well-inform them, within the next decade we shall see our culture destroyed by someone; by our own good-intentioned but not well-informed men and women, or by an external citizenry which has been well-informed, but *is not good-intentioned*.

BOOK REVIEWS

COCANNOUER, JOSEPH A. *Tramping Out the Vintage.* Norman: University of Oklahoma Press, 1945. 221 p. $2.75.

Tramping Out the Vintage may be considered a partial answer to the earlier and better known *The Grapes of Wrath.* Whereas the latter was based on a vivid imagination for the most part unsupported by facts, the former is a product of real experiences accumulated through actual contact with the soil and the peoples who cultivate it.

Written in a whimsical, most readable narrative style, the author makes a most serious appeal for America to regain or reclaim its rich heritage—the virgin soil, much of which has already been lost by careless, wasteful farming methods. Cocannouer uses his boyhood in Oklahoma as an example, but it is as true of most, if not every state in the Union. Our wanton waste of not only our soil resources but almost every other resource—timber, petroleum, gas, wild life, minerals, humus—cannot but add up to a national disgrace that will plague us to our embarrassment in the future years ahead. As the author points out, tending the vineyard properly is the task of every American. Too long has wastefulness and destruction in handling our soil gone on, and we will reap the misunderstanding, ignorance, and famine that will surely come unless we do an about-face. *Tramping Out the Vintage* is a voice raised in warning of the wrath to come unless Americans are made to realize that the soil is the real backbone of our national prosperity and high standards of living.

The author knows Oklahoma, its farms, and its people. Much of his love and understanding of the soil came from his wise mother. He describes the "cotton minds" whom he and his mother deplored—the careless, haphazard farmers—too indolent and ignorant to farm or probably do anything else — undesirable farmers and citizens of Oklahoma and any other state.

Cocannouer relates his early farming experience in the rich sand hills of Oklahoma, his struggle at Oklahoma A and M College for an education, his early rural teaching experience, where he tried to introduce scientific agriculture under the guise of nature study, his similar work in the more hospitable Philippines where his ideas of scientific agriculture worked better, and his later work in South China and in California.

As the author points out, introducing scientific agriculture will not become a reality in a day or even in his lifetime—but it must come. The 4-H and FAA Clubs are performing a valuable service, but in Oklahoma and other places, there is the tendency to center activity upon winning prizes rather than upon more vital problems.

This is an excellent book based on practical experience and a wealth of common sense. Thoughtful Americans can well ponder the problems that it raises. It is recommended reading for every American—adult, boy or girl—whether on a farm, or living in a city.

C. M. P.

WRIGHTSTONE, J. WAYNE AND MEISTER, MORRIS (Editors). *Looking Ahead in Education.* Boston: Ginn and Company, 1945. 151 p. $1.50.

Looking Ahead in Education is a compilation of papers by associates of Dr. Otis W. Caldwell in testimony of their esteem and friendship for Dr. Caldwell on his seventy-fifth birthday. What an excellent way to show one's regard for a man who has so richly contributed to American education, particularly to science education and the advancement of scientific knowledge. The cooperators in this series of papers were urged "to use their imaginations with reasonable restraint, to try to see beyond the horizon, even farther forward than sight makes possible, but to look mainly in the directions indicated by any existing arrows of guidance." Seemingly the cooperators have lived up to this admonition reasonably well. Altogether the papers constitute an interesting, prophetic view of what lies ahead in education.

After an *Introduction* by J. Wayne Wrightstone and Morris Meister, and *Dependable Associates* by Otis W. Caldwell, the papers discuss *What's Ahead In: Education for World Service* by Julius B. Maller; *Experimental Education* by J. Wayne Wrightstone; *Measurement* by Walter N. Durost; *Personality Analysis* by Percival M. Symonds; *Intelligence Testing* by Beth L. Wellman; *Occupational Research* by Archer W. Hurd; *Elementary Education* by James S. Tippett; *Rural Schools* by Effie Bathurst; *Reading* by Arthur J. Gates; *Teaching of History* by John C. Knox; *Social Studies* by Daniel C. Knowlton; *Science in General Education* by Morris Meister; *Biological Science* by J. Winfield Tietz; *Research in the Teaching of Science* by Francis W. Curtis; *Secondary School Mathematics* by Raleigh Schorling; *Music Education* by Satis N. Coleman; *School Library* by Anne T. Eaton; *The Effects of Military Training in Education* by Victor H. Noll; *Co-operative Authorship* by Charles E. Skinner; and *Authors and Publishers* by Ernest N. Stevens. There is also a contribution by Jerome Kuderna entitled *Science Education at the Crossroads.*

C. M. P.

WILLIAMS, PAUL R. *The Small Home of Tomorrow.* Los Angeles (1622 N. Highland Ave.): Murray and Gee, 1945. 95 p. $3.00.

When labor strikes are finally settled and building materials are available, there will be one mad scramble to build the ten million new homes Americans need. To plan intelligently, a prospective home builder needs to consult all sources of information and aid possible.

Money spent this way will likely pay big dividends in savings as well as future comfort and satisfaction.

In this book a noted architect presents forty floor plans and elevations of modern homes in a price range from $3,000 to $10,000. Outlined in detail are the Kitchen of Tomorrow and the Bathroom of Tomorrow. Modern trend of color in decoration, financing, selecting the site, and do's and don'ts in planning a house are discussed. In an architect's notebook addendum, the following are commented upon briefly: relative costs of labor, materials, site, and profit; insulating materials; air-conditioning; heating; stoves; sinks; laundry units; refrigerators; paint; electric lighting; plastics; prefabrication; and light metals.

Working drawings and detailed specifications for the homes illustrated may be obtained at a cost ranging from $60.00 to $75.00.

R. J. A.

Alsop, Stewart and Braden, Thomas. *Sub Rosa—The O.S.S. and American Espionage.* New York: Reynal and Hitchcock, 1946. 237 p. $2.50.

This is the story of the late Office of Strategic Services, a vast and chaotic organization of 12,000 people who did many different things. The idea was Major General William J. Donovan's and he organized this under-cover agency of men and women recruited from Wall Street, labor, students, white collar workers, university professors, and so on.

The authors impressively outline the contributions of this organization, new in American life and already disbanded, in the fields of Intelligence and Resistance. The two authors have written this book out of their own experiences in the O.S.S. Both were members of the Jedburgh mission that jumped behind the lines in France to aid the Resistance movement. This story is vividly told, as well as many others. One is not likely to soon forget the story of Billy and the Seal Mission in the Netherlands, the story of Captain Hall's mission in Italy to block the Brenner Pass, nor the story of the Standish Mission, the boy Alcine and the German spy—the French girl Reneé.

Altogether, *Sub-Rosa* is the interesting story of a wartime agency that did an excellent service in the war effort.

C. M. P.

Jagger, T. A. *Volcanoes Declare War.* Honolulu, T. H.: Paradise of the Pacific, Limited, 1945. 182 p. $3.75.

Probably no man in the world knows more about volcanoes than does Dr. Jaggar. For 25 years he lived on the rim of the world's most active volcano as Director of the Observatory at Kilauea. He has conducted six expeditions to the Aleutian Islands, seven to the volcanoes of Japan, three to the South Seas, and others to Chile, the Philippines, Java, the Caribbean and western North America. This treatise is based on that wide experience and is valuable both to the professional geologist, the science teacher, and to the layman. Altogether this is one of the most comprehensive discussions on the subject of volcanoes that has been published.

Numerous illustrations are included, as well as nearly 150 photographs, three of which are in color.

Truly a ring of fire encircles the Pacific and many regions are now only quiescent, for example those of the Cascade Mountains in the Western United States. Volcanic activity has been greater at times in the past but in comparatively recent times have been very destructive of life. More than 36,000 persons lost their lives in the great volcanic eruption of Krakatoa on August 27, 1883. This is often described as the greatest volcanic eruption known to man. The sound was heard nearly 3,000 miles and an air wave was sent around the world. It is said every square mile of the earth's surface received dust from this eruption, and there were unusually beautiful sunrises and sunsets following this. However, Dr. Jagger believes that the eruption of Tomboro on April 10, 1815, may have actually been bigger. Nearly 50,000 people lost their lives either directly or indirectly as a result of this eruption. Other writers have assigned this eruption as at least a partial cause for the unusually cold summer of 1816 in the eastern United States—known as the "year without a summer"—frost during every month, and even snow in most New England states.

C. M. P.

Linton, Ralph (Editor). *The Science of Man in the World Crisis.* New York: Columbia University Press, 1945. 532 p. $4.00.

The object of this book is to apply the knowledge and techniques of anthropology to the present crisis that is facing peoples of all parts of the globe and of many different cultures. Edited by a noted anthropologist, Dr. Ralph Linton of Columbia University, this collaboration is the work of a group of experts, each summing up and evaluating the contributions of his special field of anthropology to the solution of the world crisis. The book is authoritative and provocative, providing an excellent background for constructive thinking about the postwar world. Twenty-two individuals make contributions to this symposium.

Some of the chapter headings are as follows: The Scope and Aims of Anthropology, Society and Biological Man, The Concept of Race, Racial Psychology, The Concept of Culture, The Common Denominator of Cultures, the Processes of Cultural Change, The Present State of World Resources, Population Problems, The Acquisition of New Social Habits, and

Nationalism, Internationalism, and the War.

An excellent book for any science teacher, the chapters on society and biological men, concept of race, world resources, and population problems are most pertinent.

Dr. Linton in the opening statement says "the present period is the first time in the world's history in which men have turned to science for aid rather than to the supernatural." Taken alone this statement would seem overly optimistic, but later on he says "In the past he (man) has always turned to his gods for the explanation of present calamity and for advice on how to mitigate it. These two are equally necessary to his peace of mind. Discomforts become somewhat more bearable if their causes are understood. Today he turns with the same blind faith to the new god, Science, and expects from it everything that the old gods provided. This made the present a field day for charlatans, especially those who volunteer to foretell the future. However, the true scientists find such faith embarrassing. No one knows the shortcomings of a God as well as his own priests and those who devote their lives to the search for scientific truth realize better than anyone else how little they know."

C. M. P.

BAKER, RACHEL. *The First Woman Doctor.* New York: Julius Messner, Inc. 1944. 246 p. $2.50.

Pioneers in every field of endeavor have had to overcome great difficulties—so often difficulties that are the result of prejudice and ignorance. Very few persons were ever subjected to more personal scorn and ridicule than Elizabeth Blackwell, the first woman doctor in the world. Rejected by all medical colleges, she finally gained admittance to Geneva College (now Hobart) as the result of a joke, an exuberant prank played on the faculty by a mischievous student body. Graduating two years later in 1849, she found the same jeers and insults when she attempted to rent an office to begin her practice. Doctor Blackwell was the first woman to enter and graduate from a medical college, the first woman interne in a hospital, the first woman enrolled on the Medical Register of Great Britain. She founded a great women's hospital in New York City, a medical college for women, and the first school of nursing in America. Through her ideas and her writings she has exerted a great influence on medical practice.

This is one of the finest, most interesting biographies the reviewer has ever read. The writer makes the reader re-live with Dr. Blackwell her thoughts, tribulations, and high ideals. Dr. Blackwell died in 1910 at the age of 89, leaving footprints on the medical sands of which every American may well be proud.

R. J. A.

DIETZ, DAVID. *Atomic Energy in the Coming Era.* New York: Dodd, Mead and Company, 1945. 184 p. $2.00.

This is the most complete popular account yet published of the developments along the way to the discovery of atomic power. This is the beginning of the Atomic Age, so dramatically ushered in by the explosion of the first atomic bomb on July 16, 1945 near Los Alamos, New Mexico. A short time later on August 5, Hiroshima felt the first application of atomic energy in warfare and the next day the whole world was informed of the greatest discovery made by man, some say since the discovery of fire. As a war weapon, certainly no discovery, not even gunpowder, has equalled it. Surely no other discovery has so aroused man's thinking or held such potentialities for man's destruction or for his advancement. The dreams of scientists down through the ages had now become a terrifying reality. The future may well be viewed with understandable misgivings. Man's way of life and thinking will be revolutionized. Does mankind have the intelligence and the cooperative good will to control its latest brainchild for the benefit of all the human race or will it prove to be the device that led to its final destruction? Only the future will supply the answer.

The author, one of America's best popularizer of science, traces man's long road to the discovery of atomic energy. The account is most readable, void of undue technicalities, and yet most accurate. Unquestionably it is the best popular account available to the layman, to the science teacher, and to the science pupil.

C. M. P.

SOLOMON, ARTHUR K. *Why Smash Atoms?* Cambridge: Harvard University Press, 1946. 204 p. $3.00.

When it first appeared, *Why Smash Atoms* was the first book on atom-smashing. In this new revised edition, important information released by the government since the atomic bomb has been included. This book does an excellent job on the what, the why, and the how of atom-smashing. Numerous photographs and illustrations, including several on the atomic bomb explosion in New Mexico, supplement the explanatory material.

Part I explains the nature of the atom and presents the progression of ideas and discoveries that have clarified man's concept of the nature of matter.

Part II explains how atoms are smashed—the artificial transmutation of matter by the voltage doubler, the Van de Graaf generator and the cyclotron; and the use of the Geiger counter and the cloud chamber.

In the final section the author discusses the importance of atom smashing to various other fields, concluding with a final chapter on the atomic bomb.

A glossary defining technical terms will be most useful to lay readers and many science teachers. However, the treatise is about as simple as it is possible to make a highly technical subject. Many high school chemistry and physics students can read it understandably and profitably. *Why Smash Atoms* is concrete evidence that highly technical information and concepts in science can be presented so as to be easily understood by educated laymen without loss of accuracy.

R. J. A.

JORDAN, VIRGIL. *Manifesto for the Atomic Age.* New Brunswick, New Jersey: Rutgers University Press, 1946. 70 p. $1.50.

In this wise and philosophical essay, the author faces with the candor and the courage of a richly mature mind, the dilemmas which confront modern man as the age of alchemy atomizes him into a kind of communal molecule. Everywhere material values are vanishing, the fixed ideas of finance, of labor, of land, of international trade, of government, and of morality. Out of lumps and bits of nothing the future is building its new tower of blocks. What will it be like? The author, who is President of the National Industrial Conference Board, discusses this future of man, with his control of atomic energy.

R. V. M.

HAWLEY, GESSNER G. AND LEIFSON, SIGMUND W. *Atomic Energy in War and Peace.* New York: Reinhold Publishing Corporation, 1945. 211 p. $2.50.

This brief book intends to present essential facts only. The first part of the book is devoted to principles and the second part is based on the official War Department report of the atomic bomb project. The final section discusses future military and industrial applications of atomic energy in the light of present knowledge. The account is non-technical and quite readable—suitable both for the laymen and the high school chemistry and physics teacher or pupil. One is not likely to find a more readable elementary account, yet scientifically accurate.

R. J. A.

TEALE, EDWIN WAY. *The Lost Woods.* New York: Dodd, Mead and Company, 1945. 326 p. $4.00.

This delightful book by Mr. Teale bears the sub-title, "Adventures of a Naturalist." To Mr. Teale such things as the return of the king crabs, a flight of hawks, the tiny insect on a wild cherry leaf, the coming of the twilight, the heart of a cloud are real adventures which began for him when he rode with his grandfather into the woods for a load of firewood when he was a boy of six. Unusual naturalists are met along the way with this great naturalist as we travel with him through the pages of this memorable book: Dr. Ditmars and his reptiles; Dorothy Richards, the Beaver Woman; the Cicada Man, William T. Davis; the artist, Roger Tory Peterson and Malcolm Rix with his models of extinct birds and many other naturalists. Particularly interesting to those of us who have seen nothing more than the "endless stream of human corpuscles" passing along Times Square are the adventures of Naturalist Teale on the same spot. Some two hundred nature photographs selected from negatives over a period of years make this book an absorbing adventure with the author.

G. O.

KNIGHT, CHARLES R. *Life Through the Ages.* New York: Alfred A. Knopf, 1946. 66 p. $2.00.

This is a popular, picture-science story of prehistoric animal life. In an entertaining, clear and graphic way the author makes real those fascinating times when strangely fearsome creatures roamed the earth. Life is shown to be continuous since its first inception, but new forms have been constantly altered and shaped by their surroundings. As much a part of this delightful book as the interesting textual material, are the author's many artistic representations of prehistoric life. Many of his paintings of prehistoric life are permanent collections of the American Museum of Natural History, the Field Museum, and the Museum of Los Angeles. More than thirty full-page drawings are found in *Life Through the Ages.*

Typical life of various geological periods is described and depicted, such as the Cambrian, Devonian, Carboniferous, Permian, Jurassic, Cretaceous, Eocene, and Pleistocene periods.

This is one of the most attractive and authoritative books on prehistoric life that a school or public library could have. Biology teachers will find it most useful for suggested supplementary reading. Elementary science teachers can refer to it is an understandable and authoritative reference.

G. B. K.

COUSINS, NORMAN. *Modern Man Is Obsolete.* New York: Viking Press, 1945. 59 p. $1.00.

The implications of atomic energy deserve and are receiving widespread attention. Science teachers who may not have seen the editorial, "Modern Man Is Obsolete," which appeared in *The Saturday Review of Literature* the same month that the atomic bomb fell on Hiroshima, may now study this greatly expanded version.

In it Norman Cousins shows "why the power of total destruction as potentially represented by modern science must be dramatized and kept in the forefront of public opinion." Aside from the text of the expanded editorial, the volume

includes various germane quotations from Epictetus, Alcaeus, Erasmus, Pascal, Bacon, Spinoza, Pope, Hume, Paine, Dostoevski, Tagore, and excerpts from *The Federalist*.

Its main thesis is that just as after the American Revolution the Confederation of States was insufficient, so today rival nationalisms are obsolete and must be replaced by a higher sovereignty. "A common world sovereignty would mean no state could act unilaterally in its foreign affairs. . . . It would *not* mean that the individual state would lose its *jurisdiction* over its internal affairs. It would *not* mean the arbitrary establishment of a uniform ideology all over the world."

Science as facts, formulas, laws, and gadgets is almost universally accepted and used but the essence of science as a way of solving problems, whose function is "diminishing the area of the incomprehensible." Science is neither generally understood nor incorporated into man's thinking. Here is the crux of science teaching.

Pondering such books as this is one means whereby science teachers can increase their influence and count for more progress in human affairs.

M. E. O.

SIGERIST, HENRY E. *Civilization and Disease.* Ithaca: Cornell University Press, 1944. 255 p. $3.75.

Civilization and Disease is based on the author's Messenger Lectures delivered at Cornell University. Dr. Sigerist is William H. Welch Professor of the History of Medicine in the Johns Hopkins University. The fascinating book is excellently written in a most readable literary style. Its charming simplicity catches the reader's interest and holds it throughout. Many highlights and side-lights in the history of disease and civilization are presented, often interestingly and philosophically interpretative. Anyone reading the book will thoroughly enjoy it. It is highly recommended to the science teacher, the layman, and for the science library.

The broad score of the presentation is shown by the chapter headings: (1) Civilization as a factor in the genesis of disease (nutrition, food habits, alcohol, dress, housing, sanitation), (2) Disease and economics, (3) Disease and social life (position of the sick man through the ages; the leper, the venereal patient, the mental patient), (4) Disease and the law, (5) Disease and history (the Justinian plague, the Black Death, typhus, the King's Evil), (6) Disease and religion (magical medicine, cures of Christ, healing saints), (7) Disease and philosophy, (8) Disease and science, (9) Disease and literature, (10) Disease and art (portraits of sick people, healings of Christ and the saints, leprosy, and plague.), (11) Disease and music (musical therapy in antiquity and the middle ages), and (12) Civilization against disease (medicine as craft and science, progress achieved, unsolved problems, health conditions not good enough, the task of the future.).

C. M. P.

HAAGENSEN, C. D. AND WYNDHAM, E. B. LLOYD. *A Hundred Years of Medicine.* New York: Sheridan House, 1943. 444 p. $3.75.

This is one of the most interesting books that the reviewer has ever read. In retrospect the advances made by medicine in the last hundred years are almost unbelievable. Sanitation and health conditions were such in cities a century ago and the people so ignorant along these lines, it is really a miracle that any people survived the many diseases that plagued them. But man has learned the value of sanitation, the causes of many diseases, how to control pain and many diseases, hemorrhage, infection, and shock.

This is a book for the layman, the science teacher, and any person interested in medicine. The great diseases are dealt with individually and historically so that a constructive account of the progress in the control of each is provided. Much interesting material about the lives of the men who have made the medical advances has been included. Surely no other science has a more interesting history than medicine and the authors of this treatise have done an outstandingly good job. Dr. Haagensen is a surgeon and pathologist on the faculty of Columbia University's School of Medicine. Dr. Lloyd is a specialist in public health in England.

R. J. A.

DAVIS, MAXINE. *Women's Medical Problems.* New York: Whittlesey House, 1945. 220 p. $2.00.

Much of the material in this common-sense, accurate, and up-to-date discussion has appeared in *Good Housekeeping.* It tells of the diseases and pathologic conditions affecting women. An excellent book for high school girls as well as lay women. The chapter on cancer—what is known about it, possible causes, treatment, preventive measures, and things to remember, is especially good.

R. J. A.

STERN, BERNARD J. *American Medical Practice in the Perspective of a Century,* New York, The Commonwealth Fund, 1945. 156 p. $1.50.

Every science teacher would do well to get this book by whatever means he may command and read it rapidly, including the 14 tables and the Appendix (reading time three hours). Foot notes and reflection can wait for slow reading.

The history of medicine has been the history of science, not to say civilization, until within a century. But neither science teachers nor medicine men have been called upon to know

anything about their antecedents. The pressure to learn the arts and the mysteries of their trade has in both cases been too urgent. Doctors have usually considered preoccupation with medical history an amiable and harmless pastime for those who cared for that sort of thing. More and more medical schools, however, have been offering students medical history as a valuable orientation for both clinical and research workers.

In the past twenty years or so doctors (and teachers) have been growing restless regarding a hundred questions which they had not had to think much about because, along with other learned persons, they took the answers for granted as lying in the nature of this best of all possible worlds for intelligent and decent and successful people. Like ordinary persons who sometimes found their incomes uncertain or inadequate, doctors (and teachers) have been wondering why *they* could not have a reasonable share in the great material enrichment of our times. Like the newer professions, including the teaching business, doctors have been wondering what's been happening to the world while they were busy doing their stuff competently and conscientiously with never a thought to private advantage. The New York Academy of Medicine has undertaken to study just these questions, through its "Committee on Medicine and the Changing Order." This little book by Dr. Stern is the first of its monographs.

This then is not a history of medicine in any sense: it is a survey of the social and technical and economic world within which doctors were finding themselves more and more frustrated and more and more in conflict with their traditional ethics and ideals. And that is why this is of special value for science teachers. For science teachers are training prospective doctors as well as prospective scientists and engineers, prospective teachers of all kinds as well as prospective citizens, managers, labor leaders and politicians. And they are doing so on the strength of what they once were taught, but in a changing order that most of us have not yet grasped. Here science teachers find themselves inexplicably pushed around by persons and forces that disregard their purposes; and here they find the results of their efforts disposed of by others whose values are utterly foreign. If our daily work means to us more than the job, we shall find this objective study of what has been happening both stimulating and enlightening.

B. C. G.

Cannon, Walter B. *The Way of an Investigator.* New York: W. W. Norton & Co., Inc., 1945. 239 p. $3.00.

In a new volume, Walter B. Cannon recalls some of his activities and records some of his thoughts resulting from forty years of service as a researcher and teacher. As Emeritus Professor of Physiology of Harvard University, Dr. Cannon draws from a varied experience in his field to discuss his concepts of the purposes and principles of scientific research. Illustrative anecdotes not only increase the appeal for scientific and lay reader alike, but also provide additional insight into the character of a social-minded scholar. There is inspiration for students of science in descriptions of the attractions and trials of scientific investigation.

Professor Cannon presents analyses of scientific investigation in several fields including his own, to indicate factors involved in the success of such enterprises. He specifically names personal attributes which he considers important for investigators and discusses the effects of external conditions upon scientific accomplishment. Financial dependence of researchers is considered in its relation to the advancement of science. The author surveys pertinent evidence relating to the question as to which are the most productive of a scientist's active years.

One chapter is devoted to a treatment of the role of hunches in the solution of investigative problems. There are references to personal and other representative experiences of sudden illumination of difficulties. Such manifestations are given foundation in an analysis of probable pertinent factors.

In dealing with the aspect of scientific progress, which involves the making of unexpected discoveries which are unrelated to the subject of investigation, Dr. Cannon defines and uses the term "serendipity" and considers instances of its importance in the extension of scientific knowledge. A defense of teleology as an aid to scientific hypothesizing is supported by examples of its influence in physiological discovery.

Dr. Cannon expresses belief in the need for a developed social consciousness in the scientific researcher. Civic responsibilities of the scientist are emphasized. Thoughts on the problem of dissemination of results of investigation to the lay public and on the relation between investigation and classroom teaching are included. Dr. Cannon shares his views that social units have the same need for balancing mechanisms as living organisms and suggests the obligation of scientists to direct their studies toward providing society with a greater understanding and more effective means of control of human behavior.

Although no substantiation is offered, Dr. Cannon states a belief that present public education has failed to qualify the citizenry for understanding new scientific advances. Further, he makes a plea, not only for teaching scientific thinking, but also for attention to the esthetic satisfactions to be found in scientific studies. Educators may find interest in considering a suggestion that the case study method used in teaching medicine and some other fields be applied more widely.

The work is autobiographical only insofar as material concerning the author is included to clarify his presentation. From his own personal experience during world war I, Dr. Cannon tells of his duties while serving actively to discover the nature of wound shock. Also of a personal nature are the references to his fellowship with collaborators in his own and many other countries. The book abounds in illustrations of scientific achievement in the fields of medicine and physiology drawn from the experience of the author and his colleagues.

A parallel between scientific exploration and geographic exploration is drawn as a means of focussing attention to the methods of investigative scientists. Though loosely organized, there is specificity in the thoughts expressed. From reading Professor Cannon's words one derives a concept of the enthusiasm for investigation and exposition which has enabled him to attain a position of eminence in his field.

G. S.

MINOT, JOHN CLAIR. *The Best Animal Stories I Know; The Best Bird Stories I Know; and The Best Stories of Exploration I Know.* Chicago: Wilcox and Follett Co., 1945. 317 p. each. $1.00 each.

Each of these books consists of a series of stories assembled from numerous writers. Most of the stories are commonly known. Some, if not a majority, are probably fiction, but have been enjoyed by many readers. Teen age boys and girls will enjoy these well-selected stories. In the animal and bird stories, those portraying the best qualities of animals and birds have been selected.

The animal stories include *The Cat* by Mary E. Wilkins; *Big Reddy, Strategist,* by Walter Eaton; *Jackal of the Deep* by Paul Annixter; *My Twenty-four Dollar Toad* by Dallas Lore Sharp; *A Wilderness Mother* by Samuel Scoville; the *Pope's Mule,* by Alphonse Daudet; *The Story of Verdun Belle* by Alexander Woollcott; *The Wisdom of "Solomon"* by Archibald Rutledge; *The Story of a Red Deer* by J. W. Fortescue; *Rusty Jones's Moose* by Charles G. D. Roberts; *The White Mare* by H. E. Bates; *A Leviathian* by Archibald Rutledge; *The Bear* by Desmond MacCarthy; *Wolves and Wolf Tales* by William J. Long; *For the Love of Man* by Jack London; *The Elephant Remembers* by Edison Marshall; and *Something* by Albert Payson Terhune.

Bird stories include: *The Oldest Bird Story*—Genesis; *The Last American* by Walter Eaton; *Sambo, the Tyrant* by C. A. Stephens; *General—A California Condor* by William and Irene Finley; *How's Zat* by Albert Payson Terhune; *The Madcap of the Waters* by William Gerald Chapman; *A Bird Medley* by John Burroughs; *The Plovers and the Patrol* by Fisher Ames; *A Gentleman in Feathers* by Charles G. D. Roberts; *Bird Migration* by John C. Van Dyke; *General Jim* by Walter Eaton; *The Mockingbird's Nest* by Olive Miller; *Peter* by Edmund Pearson; *The White Blackbird* by Alfred de Musset; and *Of Creamen the Woodcock* by M. D. Haviland.

Exploration stories include: *We Reach the Pole* by Robert E. Peary; *The Race for the South Pole* by Dugald Macmann; *How I Found Livingston* by Sir Henry Stanley; *When Columbus Found the New World; The First White Boy in America; Down an Unknown River; The Loftiest Peak* by Dugald MacMann; *Drakes Voyage Round the World; Earliest on New England's Shore* by Laura E. Richards; *What Little Portugal Did* by William Griffis; *The Dreams of the Spaniards* by William Griffis; *The Story of LaSalle* by Charles R. Hayes; *The Fate of Andreé* by George Palmer Putnam; *Henry Hudson* by John Moore; *The Death of Captain Cook* by Captain James King; *Exploring the Maya with Lindbergh* by William Van Dusen; *Christmas on the St. Croix;* and *Buffalo! Buffalo!* by Francis Parkman.

G. E. D.

FREEMAN, LARRY AND STERN, EDITH M. *Mastering Your Nerves.* New York: Harper and Brothers, 1946. 247 p. $2.00.

The subtitle of this book is *How to Relax Through Action.* It is intended as a guide to a better understanding of nervous tension and its method of release.

Part One on the whys of activity includes a self-test to determine whether you are the active-motor type, the vocal type, the idea-motor, or the organic type. The authors believe the determination of your classification will help you to better understanding of yourself.

Part Two on the hows of activity includes chapters on work to relax, play to relax, talk to relax, laugh to relax.

Part Three is on the pattern of activity and includes chapters on keeping yourself fit and the well-balanced life.

Larry Freeman is a professor of psychology at Northwestern University and Edith Stern is a writer who has specialized in the popularization of psychological and psychiatric material.

G. E. D.

GRIFFIN, ALEXANDER R. *Out of Carnage.* New York: Howell, Soskin Publishers, 1945. 327 p. $3.00.

America has played a great part in the heroic drama of the salvation of human life in battle. The story of this battle against death in war, the rescue on land and sea in the midst of mass carnage and on lonely islands and in hospitals in countless places where human life is valued and never regarded cheap, is told within the pages of Mr. Griffin's remarkable book. He tells us about aerial rescues, of serum and vaccine discoveries, of new drugs, of malarial plagues in swamps and jungles, of

"soul surgery," ice therapy, and how to survive inhuman catastrophes with humane science. Although the book has the serious title, "Out of Carnage," the author's style adds flavor to the story of individual heroism and humane science.

G. O.

SUTHERLAND, LOUIS. *The Life of the Queen Bee.* New York: Bernard Ackerman Inc., 1946. 126 p. $2.50.

The reviewer is impressed with the story of the life of the queen bee and cannot help but note a great similarity to present day dictatorship, bureaucratic, communistic types of government. The workers, the drones, the queen forcefully destroying her competitor—and then basking in comfort and security for herself and those that cater to her.

A hive of bees is a family of bees. It consists of a mother bee, several hundred drones, and thousands and thousands of worker bees. The mother bee, commonly called the queen, lays all the eggs and gives inspiration to the whole family. The worker bees are also females, but their reproductive organs are undeveloped and they are smaller in size than the queen and the drones. The workers perform the duties of nurses, undertakers, builders, chemists, masons, architects, guards, and foragers or field bees. A colony of bees or any other species of life—refers to living in close association. The average life span of a queen bee is about three years.

In discussing the worker bees, the author states that the bees perform their work in shifts. Some bees rest while others take their places or they alternate as to types of work.

The bees that gather nectar or pollen in the field one day might be the undertakers or the soldiers of the hive the following day. Those who searched for propolis yesterday might be the guard bees today. All of this work goes on systematically and orderly, without the least conflict or confusion, without the bees fighting among themselves.

The workers are true spinsters. They have no love life like queens and drones, who are true females and males, and their only pleasure is in toiling for the future of the hive, gathering stores which they will never live to eat, for the workers do not live long enough to enjoy the fruits of their labor, since the bees which store most of the honey for winter use will have died either by accident or old age long before winter begins.

Unlike the socialistic state, the bees have no provision for taking care of their old and crippled members. These cannot be maintained in the colony, for they would overcrowd the hive, consume too much honey, and the whole colony would starve in winter. So, in the interest of the hive, the bees expel the old and crippled workers when their usefulness is over. But most of them, when they feel that their days have come to an end, voluntarily leave the hive so they might die on the outside, thus sparing the others the task of removing their bodies.

The drone is a filthy, gluttonous, lazy creature. The drones are served, as it were, upon a golden platter, for they are too lazy even to sip honey from an open honey cup, unless they want a second helping—then gulp it down. In a day, a drone consumes all the honey four workers can produce. The entire life of the drone is wasted in idleness.

To summarize the whole story of the life of the queen bee, I will quote from the author, page 67;—"the society of the honey bee is a government of insect communism. It is communism carried to its final conclusion." There are 20 photographic illustrations to the book, which is a companion book to the author's "The Book of Stars."

F. M. D.

YOCUM, L. EDWIN. *Plant Growth.* Lancaster, Pa.: The Jaques Cattell Press, 1945. 203 p. $3.00.

Dr. Yocum has been an expert on plants for many years. Therefore, *Plant Growth* is an authoritative book, full of sound, practical advice on gardening with many interesting historical facts concerning plants. The many questions of his friends concerning plants stimulated the author to write this book for the layman who wants to go beyond the seed catalogue and understand some of the laws of nature in relation to plant growth and culture of plants found around most homes. There are 16 plate illustrations and twenty-five drawings.

G. O.

DUNHAM, CLARENCE W. AND THALBERG, MILTON D. *Planning Your Home for Better Living.* New York: Whittlesey House, McGraw Hill Book Company, 1945. 278 p. $4.00.

A number of fine books on planning and building homes have appeared in the last year, but none of them excel or possibly equal this one. Whether one plans to build or buy a home, an examination of such books will undoubtedly result in both a saving of money and an increase in satisfaction and happiness. This book includes over 100 photographs, drawings, and floor plans. Construction is broken down into simple elements easily understood. The many questions to which one wants to know the answers are answered here.

Detailed discussion of each part and phase of the house, as well as landscaping, garages, legal matters, financing, and supervising construction are discussed in separate chapters.

G. B. K.

BELL, H. S. *American Petroleum Refining.* New York: D. Van Nostrand Company, Inc., 1945. 619 p. $7.50.

The techniques involved in petroleum refining have progressed very rapidly in the past decade. Books have been written on the changes which have occurred in one phase of this important industry. The purpose of this volume is to combine this information and to make it readily available to the executive, engineer, student, or employer seeking up-to-date facts.

This edition has been edited in order to eliminate non-essentials in the light of present day practice, yet certain historical and developmental threads have been retained for purposes of record. References to the voluminous literature of the field have been added to guide the reader desiring further information upon specific subjects.

R. V. M.

FLOHERTY, JOHN J. *Flowing Gold: The Romance of Oil.* New York: J. B. Lippincott Company, 1945. 256 p. $2.50.

The author learned about what oil is and where, how and when it was formed from an oil geologist. Then he asked, "How is the gas formed?" "Through distillation, whether in the ground or in the refinery, crude oil when subjected to heat and pressure, gives off gas and other products." Then he asked the oil geologist, "When was natural gas put to practical use for the first time?". In Findlay, Ohio, a farmer named Daniel Foster piped gas and used it for cooking. Many centuries before, the Chinese had used bamboo pipes to transport natural gas.

Kier established the first oil refinery to be built in the United States. Dr. Abraham Gesner perfected an improved illuminant which he distilled from coal and called kerosene (coal oil, many called it). Colonel E. L. Drake was first to suggest the idea and drill for oil inside a pipe (avoiding cave-in handicap).

Tallow and other household fats were used as lubricants with negligible success but lubricants were now made from the baser part of the oil from which they distilled the kerosene.

In the refining process there appeared a product that seemed useless but was dangerous—and of all things, gasoline. How to get rid of their useless gasoline?

The Wright Brothers, the plane, and the oil from which it got its power, was just another step in the story of man's inventive genius and free enterprise.

The oilmen saw the approach of a new epoch—the oil age. At the beginning of World War II, the United States produced nearly 64 per cent of the world's oil supply. Were it not for the vision, the enterprise, and initiative of the American oil industry *over the years,* our chances of victory in World War II would have been slim indeed.

Columbus carried on his explorations horizontally; the oil driller fights for every foot of his progress vertically. Columbus completed in 69 days the exploration in which he discovered the New World. The oil man sometimes spends a year in probing the dark recesses that lie two or even three miles below the footings of his derrick. A most interesting narrative is given in the chapter on "Mile long probe."

In the chapter "Arteries of Steel" the author states that of all the crude oil produced in the United States, about 75 per cent is delivered by pipe line to refineries, while tankers, railroads and other modes of transportation carry the remaining 25 per cent.

"The United States has produced almost twice as much oil as the world combined and this in spite of the fact that we have only 15 per cent of the world's favorable oil lands. It is not beyond possibility that long before our oil gives out, atomic energy will be in everyday use."

The oil, from the pool to the consumer, in its long journey of processes and in its many handlings is rarely seen by human eyes—this precious flowing gold.

The text is supplemented with 32 pages of photographs that make clear and dramatic many important features in the history of oil from the wells to its many important uses.

F. M. D.

TAIT, SAMUEL W. JR. *The Wildcatters.* Princeton University Press, 1946. 218 p. $3.00.

The Wildcatters is an informal history of oil hunting in America. The oil game is one pioneering activity that has never had a frontier. What drives men to pursue such an occupation? Usually they seem to want the money they make for hunting more oil. It has been said that if every cent were taken away from them but the money to keep on hunting oil and a bare living while doing it, not one wildcatter would quit the oil game. Robert W. Service must have been thinking the same thing when he had his prospector declare that, "it isn't the gold that I'm wanting so much as just finding the gold."

In the drilling of the first oil well at Titusville, Pennsylvania, in 1859, oil was found just in time. Financial worries were creeping upon Colonel Drake and had he failed it might have been some time before such success would have been achieved. One is impressed with the inflation and crowded conditions under which men worked in getting the oil to market.

It was on the Farrel tract (1863) that the most profitable well ever known was located, reputedly netting about $4,000,000 in its lifetime of less than two years, and paying 100,000 per cent on the original outlay for lease and well.

The competition between teamsters, the rail-

road and then the pipeline interests in transporting the oil to market was keen and at times almost warlike.

By 1869 new uses had been found for petroleum, and an enthusiastic writer could that year exclaim "It is something to know that a cargo of petroleum may navigate a river, cross a lake or ocean, in a vessel propelled by steam it has generated, acting upon an engine it lubricated and directed by an engineer who may grease his hair, anoint his body, perfume his clothing, enrich his food, rub his bruises, freshen his liver, and waterproof his boots with the same article."

In the first decade from 1859 to 1869, while the oil pioneers had produced 25,000,000 barrels, three-fourths of the more than 5,000 wells he had drilled were either dry or abandoned.

The author states that along with the oil prospectors' chronic optimism about the future, oil men have a penchant for regretting their past mistakes, real and imaginary.

In tracing the history of wildcatting and oil hunting from Pennsylvania on into Indiana, Illinois, Michigan, Oklahoma, Texas, California, Wyoming, and then back into Illinois, one is thrilled with the experiences and achievements of the oil men.

Great figures in wildcatting were Williams, Drake and Galey, Joiner of Alabama, and Gutowsky of the late West Edmond, Oklahoma, field. This is a reserve in the 200,000,000-barrel class.

The part state geologic surveys and geologists and geophysicists played versus the oil smeller doodlebug method of oil hunting and wildcatting is somewhat summarized in the last chapter.

This is a vividly written narrative history of the oil industry of the United States, written by one who literally grew up with the oil industry, for his father went to work as a boy on wells along Pennsylvania's Oil Creek in 1869.

F. M. D.

KIVER, MILTON S. *Television Simplified.* New York: D. Van Nostrand Company, Inc., 1946. 375 p. $4.75.

Here is television explained in a masterpiece of simplification by the author of "UHF Radio Simplified." Practical television is fully explained in plain English, covering the theory, mechanics, repair and servicing of television equipment. It explains every step and completely covers the principles and practical problems involved in television operation. Frequency modulation and television circuits are analyzed and explained, as well as the actual trouble shooting methods applying to the repair of television receivers.

The author uses many charts, diagrams and illustrations to make the book more understandable to the reader. Practical chapters entitled Cathode Ray Tubes, Color Television, The Typical Television Receiver and Servicing Television Receivers, make this straightforward book a most useful aid in understanding and working in modern television.

R. V. M.

FREEMAN, SAMUEL. *Two-Way Radio.* Chicago: Ziff-Davis Publishing Company, 1946. 506 p. $5.00.

The author develops the idea and presents the proof that it is technically, financially, and legally feasible for everyone to enjoy the advantages of two-way radio communication. The field has been expanding rapidly as it emerges from wartime applications to peace time utilization. It is currently opening up a billion dollar field of business for the radio industry as well as a hundred thousand new jobs during the next five years in the United States.

Distances between the mobile and fixed stations vary with the type and elevation of the antenna at each station, conductivity of the earth, frequency or wave-length, efficiency of the receiver, and type of transmission. Ranges of ten miles are usually simple and twenty-five miles are not difficult.

Various technical aspects are discussed in not-too-technical language. Excellently written and clearly illustrated, it is a fine book for the science teacher as well as the amateur and technician in radio.

Possible users include railroad trains and systems, (some railroads now employ two-way radio and all will probably very soon); police, fire, forestry services; highway and public transportation; aeronautical and marine applications; and personal users such as doctors, farmers, hospitals and ambulances, private automobiles, and radio amateurs.

S. M. A.

MEISTER, MORRIS, KIERSTAD, RALPH E. AND SHOEMAKER, LOIS M. *The Wonderworld of Science,* Book Seven and Book Eight. New York: Charles Scribner's Son, 1944. 352 p. each. $1.44 each.

These first two books of the junior high school series continue the elementary series of the same name. In format and general appearance they are quite similar, being one of the very few, if not the only series, that does this. Having the same senior author, they present a continuity and integration of subject matter that makes the series unusual and most desirable. The authors are well-known writers and leaders in the field of science education. The books are the result of many years of teaching experience with boys and girls.

Many unusually fine and colorful illustrations supplement the textual material which has been written keeping in mind the vocabulary levels and interests of the boys and girls using the texts. Throughout the book are many sugges-

tions of "Things to Do" and "How Much Do I Remember" questions. By every educational, psychological and subject-matter test, they constitute one of the finest general science series ever published.

C. M. P.

EDDY, CAPT. WM. C. *Television.* New York: Prentice Hall, Inc., 1945. 330 p. $3.75.

Here is a complete, authoritative, up-to-the-minute account of television from basic principles of operation to how to stage a full-scale broadcast, written by an outstanding television pioneer, Captain Eddy, commanding officer of the Navy's radio and radar school in Chicago. The lay reader will enjoy the "tall tales" in the last chapter and the miniature technique used in television programming and the general reader will find a challenge in the chapter, "Television in Education." The glossary is excellent and the notes for producers will prove themselves helpful.

G. O.

FULLER, ROBERT W., BROWNLEE, RAYMOND B., AND BAKER, D. LEE. *Elements of Physics.* Boston: Allyn and Bacon, 1944. 831 p. $1.48.

To say Fuller and Brownlee, one experienced in secondary science teaching thinks physics or chemistry. Years of experience have guided these two authors and Mr. Baker in presenting to the secondary schools another edition of a standard physics text. All the basic ideas of physics are here with many practical applications and problems to reenforce them. Careful attention has been paid to the construction of a good book in keeping with what is new in physics. Significant photographs and drawings clarify the text and abundant questions and exercises assist the pupil in his learning. Automobiles and airplanes exemplifying so many principles of physics conclude the book in the last unit "Land of Air Travel."

G. O.

HOGG, JOHN C., ALLEY, OTIS E., AND BICKEL, CHARLES L. *Chemistry, a Course for High Schools.* New York: D. Van Nostrand Company, Inc., 1945. 544 p.

In the preface, the authors state that the conventional high school course has been followed with emphasis placed upon industrial processes and the ever-increasing applications of chemistry in our daily lives. The book is divided into three parts. Part I is largely descriptive; Part II is theoretical; and Part III deals with the metals, organic chemistry, plastics, rubber and foods. Some units are to be taught consecutively but others are quite independent of each other and can be studied at will. There are ample problems divided into two groups of simpler and more difficult problems. Review exercises are provided at the end of each chapter unit. There is an accompanying laboratory manual and workbook for student use although there are experiments written in the body of the text in small type which can be performed or omitted without loss of continuity of text. The theory of atoms and molecules or the constitution of things is handled well and there is a definite attempt made to help pupils solve problems of chemical arithmetic; but the reviewer would suggest that the chapter on problem solving or measuring things be postponed just a bit until the students have had some chemical changes, elements, compounds, and mixtures to make chapter 4 a bit more meaningful.

G. O.

DULL, CHARLES E. *Modern Physics.* New York: Henry Holt and Company, Inc., 1945. 598 p.

This physics text seeks to make physics significant in the lives of high school students. It is profusely illustrated and rich in human interest. The previews are good and mathematical physics is carefully taken care of and explained. Individual differences are provided for by adapting material to groups of varying abilities. The usual content of physics is organized into twelve units.

G. O.

HOGG, JOHN C., ALLEY, OTIS E., BICKEL, CHARLES L. *Workbook for Chemistry.* New York: D. Van Nostrand Company, Inc., 1945. 272 p.

This workbook follows the same sequence as the textbook by the same authors. It is not a laboratory manual, but a workbook of exercises consisting of Completions, True-False statements, Matching Statements, Multiple Choice questions, Equations and problems, together with Honor Work.

G. O.

YOUNG, C. B. F., AND COONS, K. W. *Surface Active Agents.* Brooklyn: Chemical Publishing Co., Inc., 1945. 381 p. $6.00.

The theoretical aspects of surface tension and its application to various industrial fields are treated in this comprehensive book. The relation between surface tension and other physical properties of matter and characteristics and effects of surface active agents. This is an excellent technical reference.

C. M. P.

LOWY, ALEXANDER, HARROW, BENJAMIN AND APPELBAUM, PERCY M. *Introduction to Organic Chemistry, Sixth Edition.* New York: John Wiley and Sons, Inc., 1945. 448 p. $3.50.

The revision of this well known organic chemistry includes an extended discussion of

the electronic concept of valence and the inclusion of such topics as resonance, substitution in the benzene ring, and high polymers. The chapter on terpenes has been rewritten and the list of reference books has been revised.

The more recent advances in organic chemistry which are suitable for an elementary textbook have also been included.

R. V. M.

Höber, Rudolph, Hitchcock, David I., Bateman, J. B., Goddard, David R., Fenn, Wallace O. *Physical Chemistry of Cells and Tissues.* Philadelphia: The Blakiston Company, 1945. 676 p. $9.00.

Beginning with a survey over the fundamentals of classical physical chemistry, a comprehensive discussion follows concerning the structure of simple molecules until we reach the large molecules of cell structure. Subsequent sections, 3–8, treat cell physiology and the influence of extra-cellular factors on cellular action and the passive penetration and active transfer in animal and plant tissues.

G. O.

Symposium. *The Place of Science in the Education of the Consumer.* Washington: 1201 Sixteenth Street, N. W. The Consumer Education Study, 1945. 32 p. Free.

This educational monograph is a statement prepared for the Consumer Education Study of the National Association of Secondary School Principals by the National Science Teachers Association. This report shows what an important place science holds in consumer education and emphasizes these as the four major contributions which science teachers can make: (1) To help students to use science in making wise decisions about purchases; (2) To help students to employ science in the effective use of such goods; (3) To help students to use science in improving their own production for home use; (4) To aid pupils in the wider applications of the methods of science to the solving of consumer problems.

G. O.

Jordan, Edwin O. and Burrows, William. *Textbook of Bacteriology.* Philadelphia: W. B. Saunders Company, 1945. 909 p. $7.00.

In thirty-eight chapters the various microorganisms of bacteriology are presented in a thoroughly comprehensive manner and the history and development of bacteriology revealed. The chapters in this new edition are not only brought up to date but the order of presentation altered for a more logical sequence. The book contains a great deal of hitherto unpublished material and there are many original drawings and photomicrographs.

G. O.

Francis, Devon. *Aviation.* Indianapolis: Bobbs-Merrill Company, 1945. 229 p. $2.50.

Here is a book, clear and concise on flying. Mr. Francis is editorial associate for *Popular Science Monthly.* In vivid, narrative style, the author takes you through basic flying training until you learn the "loops and rolls" that are the basis for all advanced maneuvers. In his narrative, he shows you the plane itself—why it flies and how it flies, and with simple illustrations makes you discover the principles of an airplane wing and the other parts of a plane. Mr. Francis has written a good book on a technical subject in a non-technical and yet scientific manner so that when you have finished reading the book, you almost feel that you can fly. For further study, there is an excellent glossary, a bibliography and guide to aviation organizations and air-craft manufacturers.

G. O.

Ray, Jim. *The Story of American Aviation.* Philadelphia: The John C. Winston Co., 1946. 104 p. $2.50.

Clearly portrayed in this book is military and civil aviation in the United States, from the first flight of the Wright Brothers to the most modern post-war superbombers and airliners. It is profusely and beautifully illustrated in color with 150 diagrams and illustrations by the author. In form and fact this book is one of the best that has come out; the author has portrayed the technical details so artistically that they are simple and easy to understand.

Any high school boy or girl interested in aviation will find a great interest in this new book.

R. V. M.

Parrish, Robert. *New Ways to Mystify.* New York: Bernard Ackerman, Inc., 1945. 124 p. $2.00.

People are always interested in tricks that "mystify"—things that they see but do not understand or can't explain. Popular in the past, "magicians" are as much in demand today. *New Ways to Mystify* presents thirty "tricks" that can be performed without elaborate equipment and with no more skill than the average person can muster. The author says it is all in practice and knowing how to distract the audience. Advice is given along this line. Tricks with cards, perpetual motion, disappearing objects, psychic tea-leaves, threading a needle, salt, sugar, keys, torn and restored newspaper, etc., are presented. There are illustrations by Doris Peters.

This is a fine book for science club members, for use in school assemblies, and for all "would-be" magicians.

G. E. D.

WEBER, WALTER B. *Aeronautical Instruments Projects.* Bloomington, Illinois: McKnight and McKnight, 1945. 124 p. $1.20.

Here is a book in keeping with the policy of the U. S. Department of Education to include pre-flight training courses in high schools which will bring to the student in such courses the explanation of aircraft instruments with specific instructions for building them. Such training is basically sound, for in constructing and testing their projects, fundamental principles are clarified and air-minded youths receive knowledge and skills which are a vital part of successful aviation. A few radio and communication instruments are included because of their importance to safe flying. All of the twenty-five projects were included for their educational value.

G. O.

WESMAN, ALEXANDER G. *A Study of Transfer of Training From High School Subjects to Intelligence.* New York: Bureau of Publications, 1945. 82 p. $1.75.

This study investigates the transfer of training to intelligence from several of the most popular high school courses, and evaluates techniques used in transfer studies. The problem of transfer of training is central to educational psychology. Curriculum content and methods of teaching have long been determined by the convictions held by teachers and administrators with regard to the nature, extent and conditions of transfer.

Fourth and fifth term high school students were given a series of intelligence and achievement tests at the beginning and end of an academic year. Students were grouped according to patterns of courses taken during the year. Two of these groupings were in science. Growth in subject matter competence and academic intelligence was determined. None of the school subjects was found superior to any others studied in the investigation, a finding in accord with other similar studies. On the whole, relatively little transfer was found. Students who took more courses gained more intelligence than students who took fewer courses. The study indicates the desirability of direct training in the mental processes rather than dependence on transfer from school subjects.

C. M. P.

LAIRD, DONALD A. *"The Technique of Building Personal Leadership."* New York: Whittlesey House, McGraw Hill Book Company, 1944. 239 p. $2.00.

The Hoosier-born author is a well-known psychologist who has had wide and practical experience as an industrial consultant. The textual material is supplemented by short biographies of thirty-two industrial leaders and the inside story of "how they got there." Each of the following points (and many more) are discussed in some detail: General qualities of a personality for leadership: (1) personal magnetism, (2) poise, (3) self-confidence, (4) optimism, (5) tactfulness, (6) progressiveness, (7) initiative, (8) stick-to-itiveness, and (9) power over time; rules for power over others: (1) be brisk, (2) think about the other person, (3) act optimistically, (4) treat all as if they were your superiors, (5) use constructive words, (6) stimulate creative thinking, (7) make yourself like everyone, (8) be active, (9) be tolerant, and (10) be considerate.

This is a recommended book for anyone—especially science teachers!

R. J. A.

RYDER, RAYMOND ROBERT. *"Effect of Student Teaching on Secondary-School Pupils in Achievement and Attitude."* Lafayette: Purdue University, The Division of Educational Reference, 1944. 155 p. $1.50.

This is the resumé of a study carried out in the secondary schools of Lafayette and West Lafayette, Indiana. The work of 67 student teachers (32 men and 35 women) was measured. They taught 20 different courses in 10 subject-matter areas which included biology and chemistry. The work of student teachers was compared with that of the regular teachers. Only records of paired pupils in the two groups were studied. There were 947 pupils in each group. Pupils were rated both on achievement and attitude. The experiment ranged over a period of two and a half years.

Conclusions from this study were as follows: (1) High school pupils learn as much when taught by student teachers as when taught by regular teachers. Pupils with less than average ability learn more with a student teacher; (2) Pupils are not harmed by having student teachers—they are more likely to be benefitted; (3) Pupils like the regular teacher—have a better attitude toward them than they do toward the student teacher; (4) Bright students have on the average about the same attitude toward student teachers as dull pupils; (5) Pupils think no less toward a subject when taught by student teachers than when taught by regular teachers; and (6) Good student teachers are better liked by their pupils than poor student teachers.

Traits in student teachers liked by high school pupils (in order): (1) Efficiency in presenting material, (2) Dresses neatly, (3) Knows the subject, (4) Pleasant personality, (5) Makes the work enjoyable, (6) Seems to like to teach, (7) Willing to help pupils, (8) Impartial, (9) Considerate, (10) Welcomes differences of opinion, (11) Courteous, (12) Gets along well with pupils, (13) Sense of humor, (14) Pupils feel they have learned, (15) Fairness in grading, (16) Effort, and

(17 Poise. Traits in student teachers disliked by high school pupils: (1) Faulty presentation, (2) Destroys interest, (3) Voice, (4) Lacks poise, (5) Shows favoritism, (6) Too serious, (7) Does not understand pupils, (8) Lacks self-confidence, (9) Annoying mannerisms and habits, and (10) Grades unfairly.

R. J. A.

Thomas, Charles M. *Simplified Time Chart,* New York: Cornell Maritime Press, 1945. $0.50.

This time chart in four colors shows relative times in all parts of the world. It is as easily read as a graph—in fact that is the principle on which it is made. Thus one can find the time at a given place almost instantly. It is useful in determining a ship's longitude or in timing weather reports. It is an excellent aid for the geography and science teacher.

F. M. D.

Stefansson, Evelyn. *Within the Circle.* New York: Charles Scribner's Sons, 1945. 160 p. $2.75.

As one examines the content page, the title of the first page, "North to Everywhere" captivates the geographer's fancy and interest. Turn the page and there is as beautiful a picture of an iceberg as I have ever seen. Then on page three is a diagram showing concretely how distorted are land areas in the northern hemisphere according to the Mercator Map projection. And on page 7 one reads, "In Swedish Lapland are mountains of about the richest iron ore in the world, where miners living in a model town operate the completely electrified mine. Two hundred miles north of the Circle, at Disko Island in Greenland, people bathe in mountain lakes in summertime, and several varieties of orchids bloom. All this, and much more, lies north within the Circle." The maps and pictures alone are worth all the book costs.

Few books of the year can equal this as to photography, geographic appeal and careful presentation. Greenland, Disko Island, Grimsey, Lapland, Siberia, Alaska, Canda's North and the Polar Sea are some of the places described and so mapped that the reader can easily locate the various towns, rivers, islands, bays and inlets mentioned.

Read and find out all about Iceland and the Arctic Chess Paradise far to the North.

I quote from page 88: "It has been said that the forests of Siberia are so vast that if they were ruthlessly cut down, as many of ours were in earlier days, still her abundance could supply the world for two or three centuries."

Several thousand years ago, before any men walked the western hemisphere, that part of Alaska which draws closest to Siberia became the gateway to a new world. The first to come to Alaskan shores were Mongols from Asia, who migrated over a long period of time. Some say there was a land bridge, and that they walked across it, but more likely then, as now, they came in one of man's oldest inventions, the skin boat. These numerous immigrants traveled slowly southeastward into South America, Mexico, the United States and Canada, and became our Indians and Eskimos.

Indians and Eskimos, who belong to the same family (for an Eskimo is simply another kind of Indian) became the first settlers of Alaska.

These are some of the interesting facts gleaned from the reading of this book.

I would recommend this book to the geographer, the teacher, the club womens' book review hour, the high school travel club, and above all, to the casual reader who wants a good book—and knows a good book when he sees it.

F. M. D.

Hornberger, Theodore. *Scientific Thought in the American Colleges 1638–1800.* Austin, Texas: The University of Texas Press, 1946. 108 p. In paper, $1.00; in cloth, $1.50.

This account of the teaching of science in the United States prior to 1800 is told in terms of the work at Harvard, Yale, Brown, Dartmouth, Columbia, Princeton, Pennsylvania, and William and Mary. The teaching is described by statements of entrance requirements, of course titles, of topics discussed in the courses, of apparatus used, of titles of textbooks, and of the personal habits and scholarship of faculty members.

An attempt at modern evaluation technique is found in the concluding chapter, entitled "The Effects." During the early part of the period covered, graduates of the colleges are said to have welcomed science as a bulwark for their religion. Later, there is said to have developed an awareness of areas of conflict between religious faith and scientific rationalism. One defect in the evaluation is that no effort is made to separate the effect of college science teaching from that of other agencies influencing men's thinking. Another shortcoming is that no evidence is advanced to show that the ideas attributed to various graduates grew out of their experiences in college science study.

It is interesting to note that even during the Revolutionary War, some college faculty members were "on leave for the duration;" for example, John Winthrop was said to have turned from his work at Harvard to an exploration of colonial resources for the manufacture of gunpowder and cannon.

—Richard H. Lampkin

Bates, Ralph S. *Scientific Societies in the U. S.* New York: John Wiley and Sons, Inc., 1945. 246 p. $3.50.

Here is an extensive account of the evolution of American Scientific organizations, national,

state, and local, including specialized and technological societies, beginning more than two centuries ago when Benjamin Franklin's "Junto" laid the foundations of the American Philosophical Society, the oldest science society now in existence in America. The history and influence of these science societies of the U. S. constitute the themes dealt with in the book which is a publication of the Technology Press of the Massachusetts Institute of Technology. There are five chapters beginning with "Science Societies in 18th Century America" followed by "National Growth, 1800–1865," and "Triumph of Specialization, 1866–1918," "American Science Societies and World Science, 1919–1944," and "The Increase and Diffusion of Knowledge." The bibliography itself is a contribution to the knowledge of the growth of science in America.

G. O.

TERHUNE, ALBERT PAYSON. *Across the Line.* New York: The Dryden Press, 1945. 116 p. $2.00.

Some time before his death in 1942 Terhune, the dog story writer, made some notes on *Across the Line* (Life after Death). These comprise the first part of the book. Most of the book consists of notes and comments by his wife Anise, based on her stated communications with her husband after death. If not convincing, the book is interesting and thought-provoking to say the least. It touches upon an eternal question that has perplexed man through the ages—is death the end of all? Its purpose is to assure mankind of the afterlife and to demonstrate that friends and relatives are able to communicate *Across the Line.*

G. B. K.

CLARKE, IDA CLYDE. *Men Who Wouldn't Stay Dead.* New York: Bernard Ackerman, Inc., 1945. 288 p. $3.00.

This is a compilation of twenty-eight well known ghost stories from records on the psychic and supernatural. The stories are more baffling and mysterious than fiction, yet each one is drawn from recorded fact.

G. B. K.

ALINSKY, SAUL D. *Reveille for Radicals.* Chicago: University of Chicago Press, 1946. 228 p. $2.50.

Science teachers at their meetings and in their journals often express concern as to the place of science in the curriculum. It seems, "They have forgotten that there is no such thing as a single problem, that all problems are inter-related, that all issues are part of a chain of human issues." This quotation strikes the reviewer as the chief emphasis of Alinsky's book.

Science solves problems by examining the facts. In this book Alinsky, characterized as a "hardboiled sociologist and criminologist who refuses to pull punches when he believes the welfare of the people with whom he works is being jeopardized" (*Chicago Sun*), examines the facts about popular participation in solving the problems of American life.

The book consists of three main themes: (1) definition of Radical as used by the author; (2) description of People's Organizations now functioning (See also "Back of the Yards—Democracy with Teeth," *Reader's Digest,* 48:123–126, March, 1946); and (3) program for the forming of People's Organizations.

Thomas Jefferson's definition is quoted: "Men by their constitution are naturally divided into two parties: 1. Those who fear and distrust the people, and wish to draw all powers from them into the hands of the higher classes. 2. Those who identify themselves with the people, have confidence in them, cherish and consider them as the most honest and safe, although not the most wise depository of the public interests." In his time the words Democrat and Radical were synonomous. Alinsky's list of characteristics of the Radical could be applied to the science teacher: "faces issues squarely . . . refuses to be diverted by superficial problems," and the like.

The crisis of today is the deep need of mankind for the furtherance of the "rights of man." One is reminded of other recent books by Alinsky's statement, "The world we knew as recently as yesterday is as dead as though it had died a century ago."

If a science teacher can read only part of this volume, Chapter 9, "Popular Education" is recommended. The place of science in schools depends on success in making "the community climate receptive to learning and education." Science courses must be *for* "people as scientists," not just for future research workers.

M. E. O.

LAUTERBACH, RICHARD. *These Are the Russians.* New York: Harper and Brothers, 1945. 368 p. $3.00.

A reader who wants to visit Russia through the eyes of a first-hand observer who on trips in 1935 and in 1944 spent his time there talking with people—soldiers, aviators, war plant workers, factory directors, farmers, doctors, housewives, and orphaned children— in all regions "from Baku on the Caspian to Leningrad on the Baltic, from Polish Lublin to Asiatic Alma Ata, from Smolensk to Siberian Novosibirsk," this is the answer to his wish.

For science teachers, there is particular interest (pp. 60, 282–293) in the author's special attention to their subject as it exists in the U.S.S.R. "Even before the 1917 Revolution, Russia had a distinguished tradition of individual scientific achievement," however, science is given prominent national attention today. In 1944, one of Lauterbach's informants reported that the Soviet gov-

ernment spent over tw[illegible] a half billion dollars on scientific research in[illegible]ites and nearly nine billions on the training or scientific specialists at universities and technical schools.

In that land, "Science is still something glamorous and exciting . . . girls and boys yearn for careers as chemists or botanists or geologists. From the earliest grades school children are taught the value and importance of science. Popular science magazines for all ages are more eagerly devoured in Russia than comic books or movie fan magazines are in the U.S.A."

Some way must be devised for science teachers here to overcome language and other barriers which prevent our learning more about how they do it.

M. E. O.

BEALS, CARLETON; OLIVER, BRYCE; BRICKELL, HERSCHEL AND INMAN, SAMUEL GUY. *What the South Americans Think of Us.* New York: Robert M. McBride & Co., 1945. 400 p. $3.00.

This is a symposium written by four men who have traveled and lived in the countries and among the peoples of South America and have held positions of a diplomatic nature dealing with problems that arise between the United States and South America.

Ecuador, Bolivia and Peru once made up the most integral part of the Incan Empire—the word "Inca" merely referring to the ruling nobility. Today in Peru less land is cultivated than in the days of the Incas. Pages 16 to 21 tell about the Spanish conquest and the treatment the Incas received at the hands of their conquerors.

On page 188, one learns that "if one could superimpose Venezuela on the Gulf area of the United States, it would cover Texas, Louisiana, and Arkansas. Colombia would cover Washington, Oregon, California and Arizona. The facts about the controversial issue, "Argentine beef," is most carefully reviewed.

Chile, dominated by both the mountains and the sea, is a "strip country" about 2700 miles long and about three hundred miles wide. "Chileans have to grab the mountains to keep from falling into the sea."

The story of the world-famous statue, the Christ of the Andes, is impressively told and it might well be used as a symbol of the U.N. and a lesson in how problems may be settled peacefully among nations, and peace forever, thereafter, maintained.

The size of the population, and the various nationalities that make up the total population, are given. The latter has played a great part in trade relations of South America and other parts of the world.

The United States will have to find a new pattern for dealing with South America. We must deal with her more on a man-to-man basis—and by our own example bring about more ethical relationships.

This war has swelled their treasuries and they are ready to buy our manufactured goods if only we can produce and supply them with the much-needed goods.

F. M. D.

SHOEMAKER, LOIS M. AND SHOEMAKER, MORRIS B. *Science in the Lanning Demonstration School of the State Teachers College, Trenton, New Jersey.* Trenton: Book Store, State Teachers College, 1944. 130 p. $1.00.

This is a record of science work done in the kindergarten and grades one to six. For each grade the meanings in a series of units which seem desirable are given, accompanied by suggested activities. Illustrative development units are given for grades one to five. Many cross-section drawings are used to illustrate the experiments and demonstrations used.

Methods of keeping live animals in the classroom for observation and as food for other animals should be most useful to elementary teachers teaching science. Bibliographies for various units and a general reference list are included.

Elementary science is in need of many more excellent records like this one. The reviewer recommends this record as unusually good.

C. M. P.

BEAUCHAMP, WILBUR L., CRAMPTON, GERTRUDE, AND GRAY, WILLIAM S. *All Around Us and How Do We Know* (Teachers Edition). Chicago: Scott, Foresman and Company, 1944, 1945. 80 p. and 83 p. $1.08, $1.24.

These are the teacher's guidebook for the second and third in a series of elementary science books, the first of which consisted of a series of colored pictures of unusual appeal to children. The series of pictures found in the pupil edition are included in the last part of these editions. There are four units of pictures and the teacher edition presents general concepts and lesson plans for the use of the pictures. The four units of *All Around Us* are: *Animals; Getting Work Done; Sun, Wind and Weather;* and *Plants;* for *How Do We Know: Animals; Land and Water; Plants;* and *Wheels and Levers.*

The introduction presents: (1) science in the second year of school, (2) areas of interest, (3) picture interpretation, types of pages, (4) the "unit picture" page, (5) the "picture-story" page, (6) the "generalizing" page, (7) the "fact-finding" page, (8) the "picture-experiment" page, (9) the "diagram" page, (10) the "application" page, (11) skills involved in *All Around Us* or *How Do We Know* and (12) the lesson plans.

These are unusually fine elementary science readers for both the pupil using them and the teacher teaching them. Completion of the series will be eagerly awaited by elementary science teachers.

C. M. P.

PALMER, E. LAURENCE. *Aids to Knowing Natural Science. The Birds.* Ithaca: Slingerland-Comstock Company, 1944. 276 p. $1.50.

One hundred seventy eight species of birds are described and illustrated. The illustrations are by Louis Agassiz Fuertes. The textual material includes common name, scientific name, order, family, description, breeding and living places, nests (location, description, eggs, incubation period), food, and other interesting bits of information. There is blank space at the bottom of each description where an observer may fill in the date, where seen, and activities noticed, for each given bird.

This is an excellent handbook and reference book for a biology teacher or pupil, an elementary science teacher, or any layman interested in knowing more about birds. The work is authoritative and has been most carefully done. The author is a professor at Cornell University and a noted authority on life in the out of doors.

C. M. P.

LENT, HENRY B. *Straight Up; Straight Down.* New York: The Macmillan Company, 1945. 86 p.; 96 p. $0.72 each.

Straight Up and *Straight Down* are two of a series of aviation readers, excellent for use in elementary science classes and as supplementary readers. The first named is suitable for first or second grade children, and the econd is suitable for second or third grade children. Especial attention has been paid to the vocabulary in each book.

The key emphasis in *Straight Up* is on the heliocopter and in *Straight Down* the emphasis is on parachutes and parachute jumpers.

G. E. D.

ZIM, HERBERT S. *This Is Science.* Washington: Association for Childhood Education, 1945. 43 p. $0.50.

This Is Science was prepared to meet a widespread demand by teachers who wished to learn how the field of science may be used best to enrich the experiences of their pupils. Part I discusses the basic ideas which characterize all science in every age: (1) a body of organized knowledge, and (2) the method of science. Listed are some specific aims of science for young children.

Part II suggests a science recipe for the primary teacher: (1) survey your resources, (2) watch for opportunities, (3) organize your work, (4) be prepared, (5) be honest with yourself and your class, (6) be careful, (7) bring your work to a definite conclusion, (8) keep a record for your own class use, and (9) don't be a die-hard.

Part III describes eighteen science activities in the classroom. These were contributed by various classroom teachers. Part IV discusses science experiences for social growth. Part V lists equipment, supplies, bibliography, and sources of free and low-cost material.

G. E. D.

Huber, Miriam, Salisbury, Frank and Gates, Arthur I. *Planes for Bob and Andy;* Whipple, Gertrude. *Airplanes at Work;* Cohn, Rose N., *The Men Who Gave Us Wings;* and Arey, Charles K., *Aviation Science for Boys and Girls.* New York: The Macmillan Company, 1943, 1944. 352 p., 248 p., 310 p., and 229 p. $1.12, $1.00, $1.08, and $1.12.

These four books in the Aviation Readers series are for the third to sixth grade. The books are excellently done and will appeal to a common interest of boys and girls. Including much information, the books offer a rather complete "ground school" for boys and girls of the elementary grades. The material has been carefully checked for accuracy and difficulty. They are recommended as elementary science readers and reference material.

G. E. D.

Bronson, Wilfred S. *Turtles.* New York: Harcourt, Brace and Company, 1945. 63 p. $1.75.

The first illustration in the book is of the family of American turtles. The turtle is one kind of a reptile. It is described and compared with other life. It is most interestingly illustrated showing how the turtle gets its food. Some of them are a nuisance to the fisherman. The reproduction process is told and illustrated. Can turtles hear? Learn about the burrows they dig. Written for the first grade child; an excellent gift book.

G. E. D.

Novikoff, Alex. *Climbing Our Family Tree.* New York: International Publishers, 1945. 95 p. $1.85.

According to a recent speaker, science teaching has not succeeded in giving a functioning time perspective to the students. (Dr. Lawrence K. Frank to Federation of Science Teacher Associations of New York City, 30 March 1946.)

Novikoff in a sprightly style presents this perspective in regard to the story of living things—the most exciting story in the world. Beginning with an account of the discovery in 1938 off the west coast of Africa of a lobe-finned fish (*Latimeria*) whose group was thought to have been extinct for two or three hundred million years, the author lays the basis for a beginner to examine the fossil record with discussions of "Everything Changes," "Too Small to See," "Too Slow to See," "How Do You Know?" "They Look Alike," "They Grow Alike." The grand perspective is then presented as a detective story.

A child of any age will, I believe, be fascinated by both text and picture. I was.

M. E. O.

Meyer, Jerome S. *Picture Book of Astronomy.* New York: Lothrop, Lee and Shepherd Company, 1945. 36 p. $1.75.

Although this book is intended for the primary grades, intermediate grade pupils will find it equally interesting. Dr. Clyde Fisher of the Hayden Planetarium says, "This is one of the clearest and youngest books about astronomy I have ever seen. The author writes in a simple and direct style, and has succeeded in the difficult task of relating astronomy to the child's own world." It attempts to answer the child's questions about the sun and moon, why they shine, why the earth turns and does not stop, and so on. Pictures in three colors by Richard Floethe add much to the attractiveness of the book.

G. E. D.

Ilin, M. *How the Automobile Learned to Run.* New York: International Publishers, 1945. Unpaged. $1.25.

This is a story for children of about intermediate grade level, but most anyone will enjoy the text and the black and bright-colored illustrations by Herbert Krudsman. It traces the history of the automobile from the first steam-driven wagon of the streets of Paris in 1769 to the jeeps and streamlined cars of today. Curiously enough the first bus, built by an Englishman named Gordon, had feet as well as wheels. And all the first car models looked like buggies or stage coaches.

G. E. D.

Pistorius, Anna. *What Bird Is It?* Chicago Wilcox and Follett Company, 1945. $1.00.

Twenty-three of our most common birds are shown in color with simple text about interesting habits of each. To those unable to name the bird from the picture and the story, the name is given inside the back cover. This is a most appealing and interesting book for boys and girls in the primary or lower intermediate grades.

G. E. D.

Webber, Irma E. *Travelers All.* New York: William R. Scott, Inc., 1944. Unpaged. $1.25.

This is the story of how plants go places. It tells how plants, although they cannot run or walk, do move about from place to place. Intended for the primary grades, the many colored illustrations will be enjoyed very much by the children. The scientific facts have all been carefully checked and the material tested

for vocabulary and reading difficulty in classrooms. This colorful book is an excellent addition to the elementary science bookshelf.

G. E. D.

MITCHELL, LUCY SPRAGUE. *Guess What's in the Grass.* New York: William R. Scott, Inc., 1945. Unpaged $1.50.

Animals in the grass include the field mouse, rabbits, the mosquito, and they, like the bird in the air and a squirrel in a tree above the grass knew Billy Boy was lying in the grass. But none of them harmed him but the mosquito which bit him on the nose and made a big lump on it. Green, red, and brown colors are used in the illustrations. The book is suitable as an elementary science reader in the first grade.

G. E. D.

BLACK, IRMA SIMONTON. *This is the Bread that Betsy Ate.* New York: William R. Scott, Inc., 1945. $1.25.

A delightful little book "to read" and "to see." It should be used in the latter part of the first grade in reading. It is rich in repetition of words and impressions and teaches the story of bread to the child in a poetic, charming, and artistic way. Colorful illustrations will appeal to the child.

G. E. D.

BROWN, MARGARET WISE. *The Little Fisherman.* New York: William R. Scott, Inc., 1945. $1.50.

A story beautifully illustrated and beautifully told and should be used in first grade reading classes. This book will make an excellent birthday gift for any six or seven year old child. Its pace, humor, clarity and rhythm make it a well-balanced book that children will enjoy.

G. E. D.

PARKER, WILLIS A. *Our Friendly Neighbors.* Asheville, N. C.: The Stephens Press, 1945. 26 p.

A slender volume of verse, robust with insight and replete with deft touches of great charm, this book presents our backyard friends: chipmunk, English sparrow, cardinal, rabbit, quail, robin, puppies and kittens, blue jay, toad, and towhee.

> " He will not starve for beauty who has seen
> Paired cardinals against a hedge of green."

One could wish to recite so many quotations that the entire book would be skeletonized.

Teachers of elementary science who include appreciation of the outdoors among their aims would find this a deep source of enrichment for their eager charges.

M. E. O.

ABSTRACTS

MEISTER, MORRIS. Planning Lessons for Science Classes. *The Science Classroom,* 25:1, 4, February, 1946.

Lesson plans for teachers of science should include a plan for: (1) an exploratory period, (2) presenting new concepts, (3) application of concepts, and (4) a review or drill period.

MEISTER, MORRIS. Science Bulletin Boards; When Pupils Make Reports; and Science Discussion Periods. *The Science Classroom,* 25:1, 4. November and December, 1945; January, 1946.

This is a series of three interesting discussions on teaching aids and methods.

PALMER, E. LAWRENCE ET AL. Outdoor Laboratories. *Cornell Rural School Leaflet,* 39:3–63. Fall, 1945.

This Teachers' Number discusses outdoor laboratories and the history and purposes of teachers' organizations such as the New York State Teachers Association, the New York State Science Service, the Natural laboratories of Cornell University, the New York State Teachers College natural history reserves, the New York State parks and reservations, and the national park system. There are also suggestions for outdoor laboratories, window nature study, and the use of school grounds for teaching science. An excellent annotated bibliography on camping and out-door living completes the Leaflet.

TIMMEL, GUSTAVE B. AND PALMER, E. L. Window Laboratories. *Cornell Rural School Leaflet,* 39:3–32. Fall, 1945.

This interesting and practical Leaflet discusses the following: kinds of windows and their uses, how to wash a window, raindrops on a windowpane, light through window laboratories, light on water, how the light through windows affects plants and animals, birds and mammals at the window, studying heat in the window laboratory, bird studies, and furry visitors. Illustrated.

CONANT, JAMES BRYANT. Public Education and the Structure of American Society. *Teachers College Record,* 47:145–195. December, 1945.

This is a series of three lectures delivered by the President of Harvard University at Teachers College on November 14, 15, and 16, 1945. In the first lecture President Conant argued for minimizing all social and economic differentiation. In the second lecture he emphasized that general education could not be considered apart from vocational goals, and that any realistic survey of the present situation shows vocational goals to be closely related to the social and economic family background. In the third lecture he favored the social equality of all useful labor and referred with concern to the recruitment of only one type of talented youth, namely, those needed by the professions.

ELSBREE, WILLARD S. Next Steps for the Teaching Profession. *Teachers College Record,* 47: 243–250. January, 1946.

Next steps for the teaching profession should include: (1) Making the entrance standards to teaching comparable in quality and amount to those established for other learned professions; (2) Aggressive policy of selection of promising personnel for teaching; (3) Need of making a conscious and persistent effort to portray teachers and teaching in a favorable light to the American public; and (4) Building strong teachers' associations, local, state, and national.

STONE, CHARLES H. A Pupil Project with Carbonates. *Journal of Chemical Education,* 22: 596–597. December, 1945.

The following experiments are described: formation of carbonates, the effect of heat upon carbonates, the action of acids on carbonates, organic products from sea shells, preparation of solid alcohol, carbon dioxide bubbles, preparation of sodium bicarbonate, reaction of carbon dioxide with bases, and comparison of carbonates and sulfites.

FISHER, VIRGINIA W. Postwar High School Chemistry. *Journal of Chemical Education,* 22:594–595. December, 1945.

The author makes an urgent plea for greater emphasis upon high school chemistry and an increased emphases upon pupil laboratory work and basic principles. Receiving great impetus after World War I, high school chemistry reached a peak and gradually declined in popularity as a subject. "Educators put greater emphasis on the social studies in the high school.—During this period we have seen our high school laboratories disappearing, for instead of students learning chemistry by experimenting, the high school teacher 'takes the course' as he stands before the class performing a few experiments. Oftentimes students in the last row wonder just what is really taking place on the teacher's demonstration desk."

BENJAMIN, THEODORE. Teaching the Subject of Atomic Energy—Part III. *The Science Classroom,* 25:4. February, 1946.

In twenty-four steps, this article traces the production of atomic energy.

FOSTER, LAURENCE S. Synthesis of the New Elements, Neptunium and Plutonium. *Journal of Chemical Education,* 22:619–623. December, 1945.

This article discusses the experimental work preceding the discovery of Neptunium (Element No. 93) and Plutonium (Element No. 94), the possibilities of chain reaction, and the methods of preparing and separating Neptunium and Plutonium from Uranium. Neptunium is converted into Plutonium fairly rapidly.

ANONYMOUS. Echoes Off the Moon. *Science News Letter*, 49:67. February 2, 1946.

Man has at last actually contacted the moon through specially designed radar. Pulses of high frequency were shot into space and their echoes were detected seconds later. This notable event occurred on January 10 and is the first time scientists have known with certainty that high frequency waves can penetrate the electrically charged ionosphere.

ANONYMOUS. Locates Survivors at Sea. *Science News Letter*, 49:55. January 26, 1946.

The Navy recently announced the development of "Sofar" an underwater sound system which explodes a TNT charge 3,000–4,000 feet under water and operates hydrophones at shore stations. By this device survivors can be located within a square mile of sea as far as 2,000 miles from shore. Depth of explosion is quite important. If the TNT is exploded at 600 feet, the sound is heard for distances of only 100 to 300 miles.

WHALEY, W. GORDON. Rubber, Heritage of the American Tropics. *The Scientific Monthly*, 62: 21–31. January, 1946.

Amazon rubber production reached its peak in 1912 when a production of 45,067 tons was reached. In 1941, 97 per cent of the 1,527,820 tons came from the eastern plantations that totaled 8.5 million acres. The Firestone and Ford plantations have produced far below expectations, but attempts have been made recently at plantation rubber in Costa Rica, Panama, Mexico, Columbia and Brazil. Synthetic rubber cannot yet compete, without subsidizations, with natural rubber. Latin America promises to assume a much more important place in rubber production.

ANNONYMOUS. Disease Warfare not New; Davis, Watson: Biological Warfare; International Effects; Thone, Frank: Harmful Effects Persist; Could Attack Food Crops. *Science News Letter*, 49:18–23. January 12, 1946.

This series of five articles point out that disease has played a decisive part in many wars but has not been used as an international weapon on any considerable scale. Preparations were made by the U. S. in top secret research, and the Japanese also developed germs for offense. Peacetime uses will justify many wartime medical discoveries. Biological warfare doesn't stop with surrender or armistice, and cannot be brought under control as easily as other forms of war's destructiveness.

KNOPF, ADOLPH. Strategic Mineral Supplies. *The Scientific Monthly*, 62:5–14. January, 1946.

The United States during the war urgently needed the ores of 25 different metals and 23 miscellaneous minerals. Geologists were called upon to do four important tasks: (1) determine the availability of raw materials, (2) geologic supervision at operating properties, (3) find more ore in the known producing districts, and (4) find new ore deposits. Among minerals and metals discussed are mica, oil, nickel, magnesium, aluminum, beryllium, vanadium, and tantulum. The oil situation is discussed at some length. Every American soldier overseas required more than 50 gallons of petroleum products every week and this did not include that used by the navy or our allies. Only 15 per cent of the United States has been geologically mapped on an adequate scale. The two deepest oil wells—one in California and the other in Texas—have depths exceeding 16,200 feet. Deep wells of this kind cost $600,000 to $800,000 or more.

WEY, HERBERT W. Teachers Too Make Errors. *NEA Journal*, 35:92–93. February, 1946.

Prevalent errors or bad habits in experienced and student teachers: (1) Lack of enthusiasm, (2) Using sarcasm, (3) Poor posture, (4) Talking too rapidly or too slowly, too loudly or too low, (5) Using mannerisms that detract students' attention, (6) Neglecting heat, light, ventilation, humidity, and general appearance of room, (7) Failing to learn pupils' names, (8) Standing in front of windows, blinding students who look at you, (9) Standing in front of board-work, (10) Carelessness in writing and drawing on blackboard, (11) Going too fast at beginning of course, (12) Taking for granted pupils know certain facts, (13) Trying to cover too much material in a limited amount of time, (14) Plunging into work before getting attention of class, (15) Wasting time on routine matters, (16) Failing to budget time correctly, (17) Working too long on one activity thus lowering student interest, (18) Talking too much and answering his own question, (19) Failing to prepare lesson, (20) Reciting yesterday's lesson, thus lowering class interest, (21) Failing to explain material on students' level, (22) Going off on a tangent, (23) Allowing students' ultimate interest to be sacrificed to their immediate interest, (24) Permitting pupils to recite to the teacher instead of to the class, (25) Calling on the better students too often, (26) Calling on a particular student before stating a question, (27) Repeating pupils' answers, (28) Correcting pupil's mistake to him alone instead of to the entire class, (29) Failure to observe practices of the school with respect to rules governing routine matters and general conduct of the students, (30) Making assignments at the wrong time, (31) Failing to make definite assignments, (32) Ineffective and too infrequent reviews, (33) Failing to check papers correctly, (34) Failing to give examination papers back on time, (35) Challenging pupils to misbehave in class, (36) Punishing individual students in presence of class, (37) Losing temper and letting insignificant matters upset classwork, (38) Making threats, and (39) Punishing the entire class for the misbehavior of one or two.